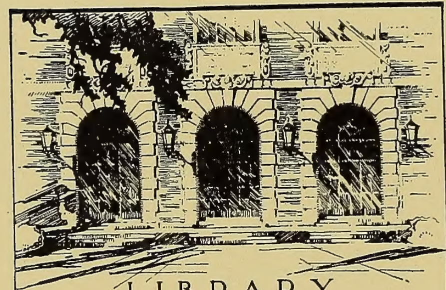

Physics

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

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TECHNICAL PROGRESS REPORT

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JANUARY, 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Construction Progress

Following is a summary of the present status of the machine in terms of transistor counts.

Operating System:		
Logic Chassis	32,412	
Spare Replacement Chassis	817	
Slow-Circuit Clamp Transistors	255	
Drum Simulator	241	
Power Supply Regulators and Protection Circuits (Estimated)	3,000	
		36,725
In Preparation:		
Chassis dc-checked	1,492	
Chassis Inspected	423	
Chassis Wired	407	
Chassis Layed Out	2,460	
Etched Boards Wired	445	
		5,227
TOTAL		41,952

Wiring on the drum main frame is virtually complete. Framing for the remainder of Interplay has been prepared for fabrication. Drawings have been prepared for the console and bids received. A thorough count of parts presently in service and available for spares seems to show that a large increase in our level of spare components is needed.

(C. Carter)

2. Computer Maintenance

Tests of flow gating have been completed using the "current probe" technique, in which currents are introduced at critical nodes of an operating circuit.

Improved plug-in suppressors, designed by H. Guckel, et. al, for use with 2N711-type transistors,[1] have been applied to several dozen grounded collector circuits in the area of bay 14 rear. As a result the behavior of the ΣO+ and ΣO- flipflops has much improved and the bay will accept the normal power supply margin tests.

The major portion of the main frame will presently accept $\pm$ ten per cent margins applied individually on each supply voltage while successfully running Snyder's NIC with data No. 3. A few bays in the repetitive MAU area tolerate only $\pm$ six per cent variation on the 25-volt supply. The blame has fallen arbitrarily on flow gating but this has not yet been resolved.

Prompted by the failure of a power supply which the monitoring circuits did not announce, the first thorough inspection has been made of the power supply protection system. Several troubles dating from the original installation have been found and corrected.

(L. Byers, H. Lopeman, R. Kingsley)

3. Paper Tape Equipment

The improved paper tape reader logic has been wired in a single card rack in preparation for test. Approximately 30 etched wiring cards are used including a computer simulator for off-line test.

(M. Faiman, R. Miller)

The following improvements have been made in the paper tape facilities:

---

[1] Color-coded orange and consisting of ten turns, AWG 32, on a ferramic H body, size CF101, coded green, parallelled by 300 ohms, 1/4 watt carbon composition.

1. Test boxes have been built to facilitate off-line adjustment and testing of Elliott readers and Teletype BRPE punches.

2. Both BRPE punches have been modified to use a flat tape reel. This change has helped to reduce drag on the tape and thus provide smoother feed holes.

3. Wiring on Soroban Computerwriter No. 2 was changed slightly in order to stop the tape reader when the carriage on the Computerwriter reaches the right-hand margin. Previous to this change, when the carriage reached the right-hand margin, the Computerwriter would hang up while the reader continued to read tape. The same change in the other Soroban Computerwriter will be made shortly.

4. All Tally and BRPE punch spare parts on hand have been cataloged and stored in order to facilitate the repair of equipment and spare-part inventory control.

(W. V. Richardson)

4. Interplay Control

The sequential control for the bench testing of the Interplay Address List core memory has been designed, built, and checked out. Tests on the memory and its driving circuits have begun.

(S. P. Krabbe)

5. IBM 1401 Interplay Channel

A modular type of cabinet has been decided upon and is being designed along with a new regulator heat sink assembly. Logic for block transfers is in the process of being checked out. It has been decided to place a portion of the Interrupt logic in the 1401 cabinet, using NOR circuitry. This logic is not yet designed. Rack and card layout is under way and back-panel wiring

will commence as soon as card connectors arrive. Mr. J. P. Booker of IBM was able to spend two days here and was able to clear up several timing problems associated with the 1041 connection. Layout of the channel control portion has begun on card racks following a logic minimization and final check.

(B. Briley, R. Willard, Y. Yen)

6. New Core Memory

Bids for the second Core Memory were received from Ampex and General Ceramics. After review of the technical proposals and discussions with the Laboratory staff, it was decided that the purchase of a 4096-word Memory with future expansion to 8192 words would be the most desirable course. This decision has led to the necessity for a rebid since the original requests for bid were not organized for clear quotation on the two-part purchase procedure. The rebidding is now in process.

(S. R. Ray)

7. Magnetic Drum Memory

A new peak detection circuit was built with a special filter in the power busses to eliminate a very high frequency oscillation that was found in the previous circuit. A File No. has been written explaining some of the problems of adjustment in the peak detection circuit.

The design (D-1330) of the clock circuitry was finished. The separation of this circuit into main blocks was done and the chassis was laid out. A trial layout of the read-write chassis was also made.

(B. Levy)

A read-inhibit circuit was designed. This circuit prevents the read amplifiers from being overloaded during writing.

(M. D. Freedman)

The coupling circuit between the head selection matrix output and the read amplifier input received much attention. The problem is to recover rapidly from writing and head selecting transients while preserving a bandwidth wide enough to preserve the pulse shape. The work is continuing.

(H. C. Brearley, M. D. Freedman, B. Levy)

8. Systems Programming

Pass III of the new assembler NICAP is complete except for pseudo-orders; Pass I is nearing completion. Thus the assembler should meet the schedule. Interrupt and special register design is under discussion, and plans should be finalized within two weeks.

(C. W. Gear)

9. Diagnostic Programming

During January, the entire set of programs for testing Normalize logic was completed in two forms:

1. Single individual programs.
2. A composite, continuous test.

Work was begun on a version of Engineering Test of Normalize to be used on the present version of ETR 103.

A program has been completed for the multiplication of two matrices using double precision accumulation. Consistent with the limited memory available at this time, 20 x 20 matrices were used for test. One hundred such multiplications were observed to occur in 16 seconds. Thus for the particular method and data used, the inner loop time was 20 μsec. This is to be compared with 10 μsec for a similar problem done on the IBM 7030, STRETCH. The difference would be somewhat less in the case of a single precision accumulation, since STRETCH gives no time advantage for reduced precision.

(J. Bouknight)

10. Operations

Total hours computer power applied		744:00
Total hours code checking		83:11
Engineering routines run:		
ETR	322:45	
ASMD	73:10	
OLF	18:12	
Duplex Memory Test	1:07	
		415:14
Other engineering (maintenance, dc speed-up, etc.)		245:35

Errors	
Punch errors	12
Reader	2
Power Supplies	6
Memory Errors	19
Faulty Components	12
Unknown	4
TOTAL	55

(W. L. Huffman)

PART II

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

An idea for a multistate flipflop has been proposed by Sergio Ribeiro. The circuit uses N transistors, where N is an even number, with exactly half of the transistors on. The number of states is the same as the number of binary numbers that can be represented by N/2 ones and N/2 zeros.

Henry Guckel has developed a theory on stability that appears to have quite general application. Tohru Moto-Oka is preparing two final reports covering the work done during his visit at Illinois. Thomas Burnside is constructing printed circuits for the statistical analyzer and reports on several circuit modifications.

2. Flipflop Circuits

The final report on switching times and waveforms of transistor flipflops is near completion and will be presented shortly.

As a by-product of the investigation referred to above, a new problem has been formulated. It is concerned with the possibility of construction of multistate flipflops, the problems of synthesis and design optimization of such circuits, and the study of their advantages and possible uses, limitations and reliability.

These multistate flipflops would consist of an even number, N, of transistors, arranged with a purely resistive circuit in such a way that a state in which $\frac{N}{2}$ transistors are ON and $\frac{N}{2}$ are OFF is stable; otherwise it is unstable. Therefore there are $S = \frac{N!}{(\frac{N}{2}!)^2}$ stable states, which is larger than the total number S' of states of a conventional register with the same number N of transistors: $S' = 2^{N/2}$.

The resistive circuit is such that to the base of each transistor is fed a voltage which is proportional to the logical majority of the collector voltages of all other transistors. Proper biasing is also obtained by adequate design of this network.

Figures 1 and 2 show respectively the logical and circuit configuration of this multistate flipflop. Some preliminary experiments and theoretical work have been carried out, and published in Digital Computer Laboratory File No. 512.

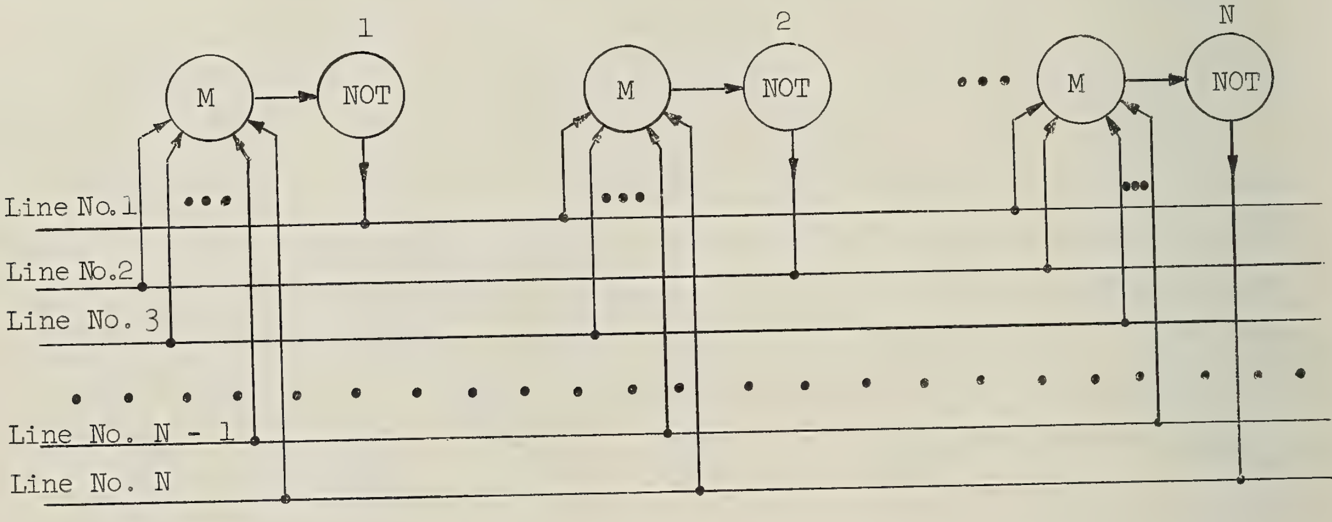

Figure 1. Logical configuration of multistate flipflop. A state is stable if and only if exactly one-half of the not-element outputs are ON.

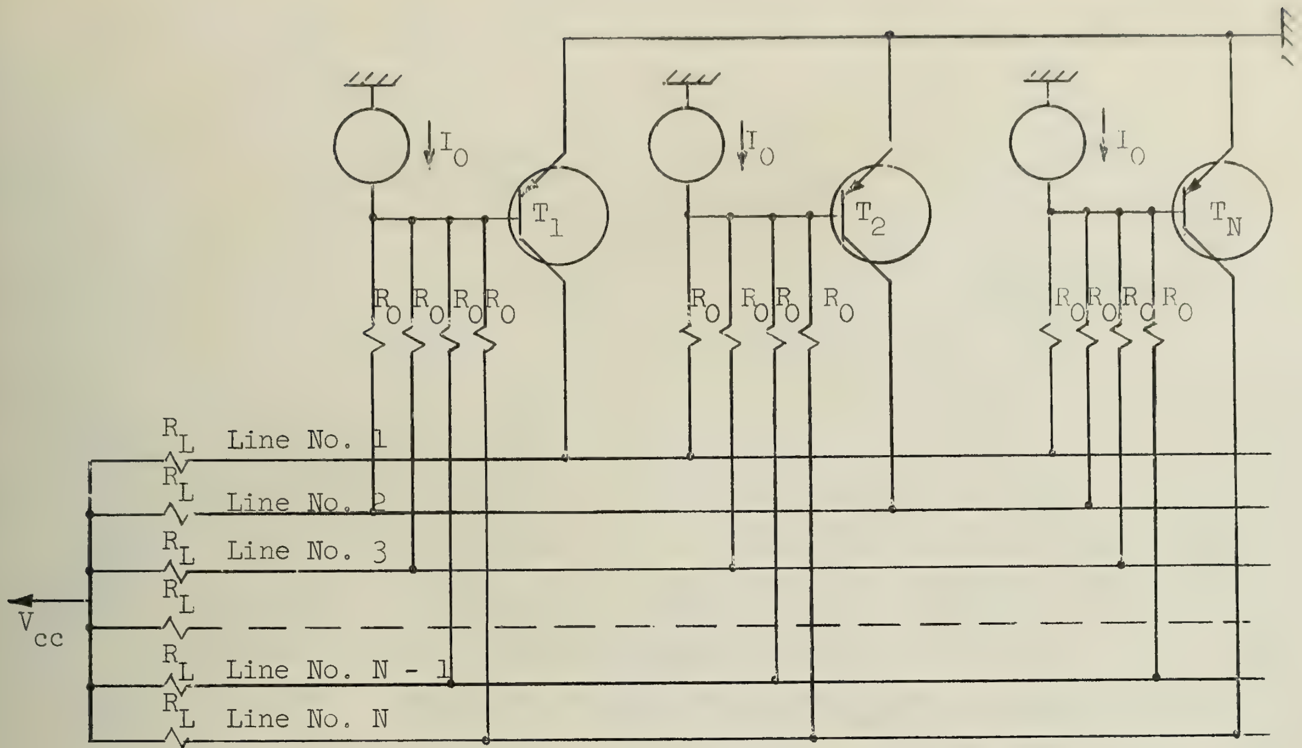

Figure 2. Circuit configuration of multistate flipflop. Majority elements are realized by resistors and not elements are realized by common emitter transistors.

(S. Ribeiro)

3. Tunnel-Diode Distributed Systems

The stability analysis for circuits containing non-linear negative resistances was completed. The problem was treated by defining an active circuit element and its dual, which are used to represent the general negative-positive RLC circuit when suitably interconnected. The stability conditions for the element are expressed in terms of the complex frequency root locations and the behavior for real frequencies. Modifications due to non-linearities are introduced. The properties of the basic element are combined with a set of interconnection rules, which render the total system stable.

The tunnel-diode tester was completed and checked. Measurements of the 5-ma tunnel diodes indicate that selection into switching and amplifying types is necessary. This is due to the large range of diode capacities, which

is to be expected. Ten-ma GaAs diodes were found to be stable and extremely linear in the negative region.

(H. Guckel)

4. Tunnel-Diode Circuit Theory

Two final reports on very high-speed tunnel-diode circuits are being prepared. The title of the first report is "Tunnel-Diode Circuits Based on Lumped Constant Circuitry." In Part I of this report, resistive four-terminal networks with negative resistances, matched to the input and the output resistance, are investigated. Hybrid circuits and revised Goto-pair circuits are proposed as examples of the application of this theory. In Part II, the hybrid circuits, composed of tunnel-diode networks and transistor emitter followers, are investigated. These circuits are expected to be the most practical high-speed switching and logic circuits in the next stage of high-speed digital circuit technology.

The second report is entitled "Tunnel-Diode Circuits Coupled into Transmission Lines." This report contributes to the preparatory stage of more ambitious attempts to achieve extremely high-speed tunnel-diode circuitry.

(Tohru Moto-Oka)

5. Statistical Analyzer

Progress has been made in producing the statistical analyzer on printed circuits. Also several circuit changes have been made.

A mistake has been found in the circuit which starts and stops the statistical analyzer described in the November, 1962, progress report. The modified circuit is shown in Figure 3.

The circuit to start and stop the output counters described in the December, 1962, progress report has been modified as shown in Figures 4 and 5.

A low current indicator bulb has been found that allows the circuit shown in the August, 1962, progress report, page 7, Figure 3, to be replaced by a circuit which has only one transistor. The new circuit is shown in Figure 6.

(Thomas Burnside)

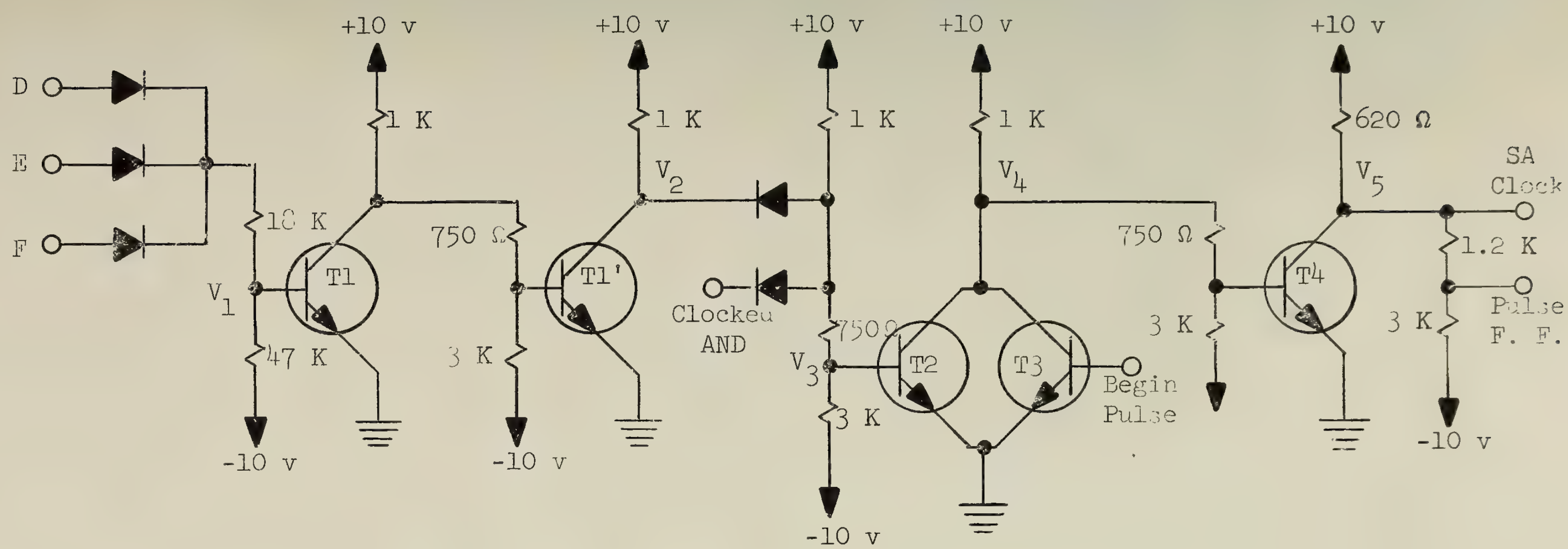

Figure 3. Circuit to Start and Stop the Statistical Analyzer

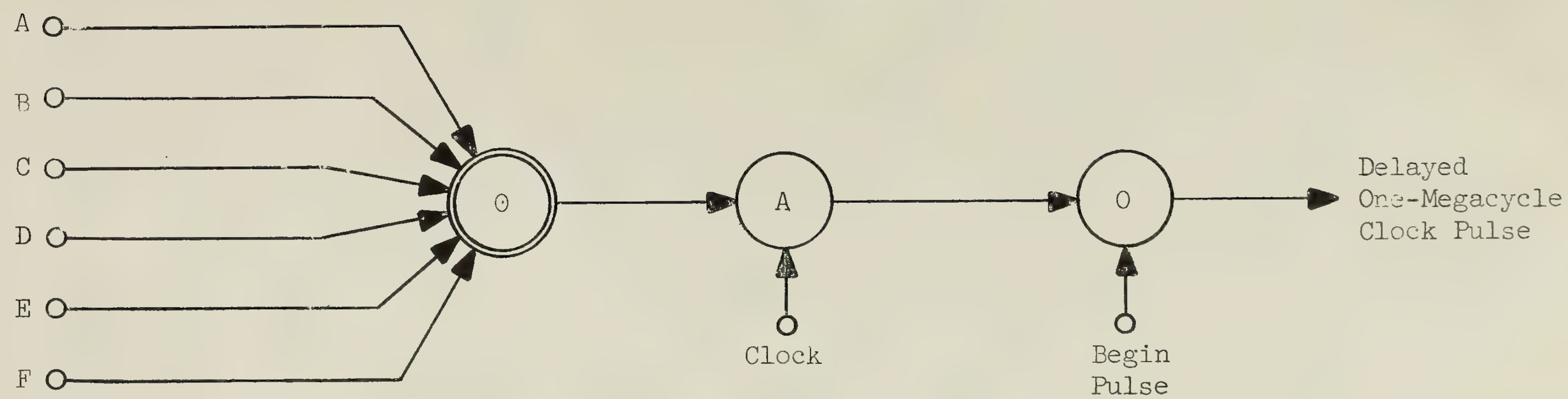

Figure 4. Logic to Start and Stop the Output Counters

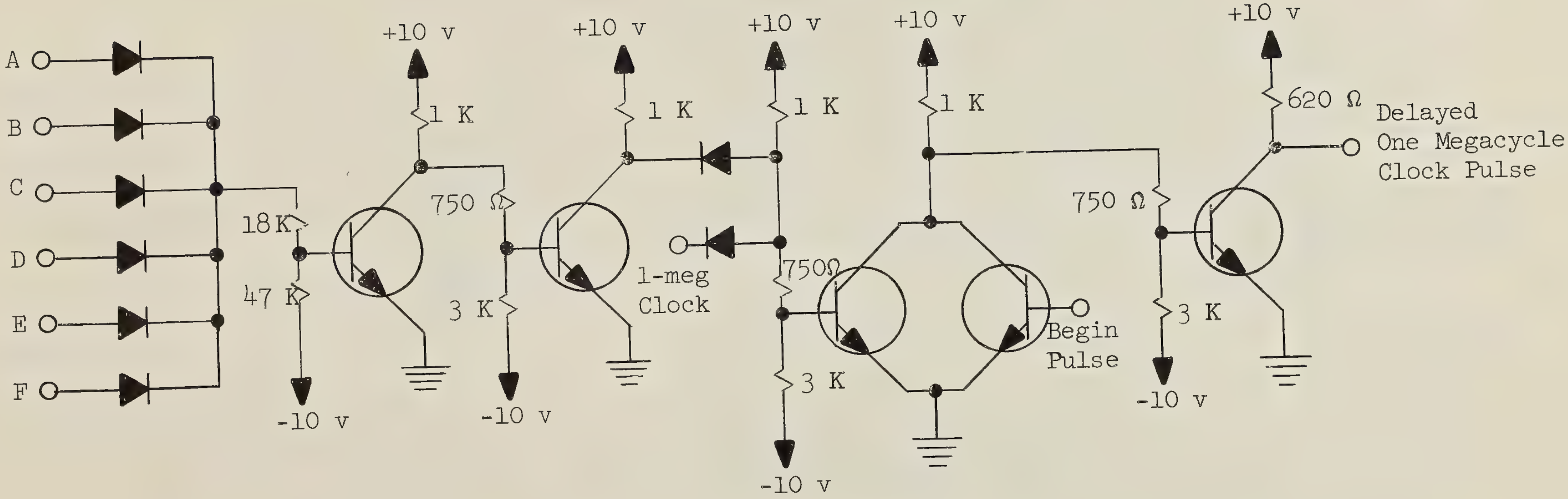

Figure 5. Circuit to Start and Stop the Output Counters

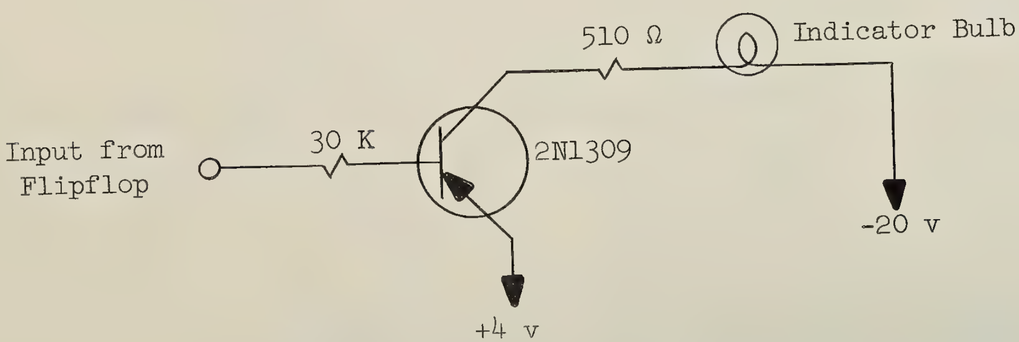

Figure 6. State Indicator Circuit for Counter

PART III

SWITCHING THEORY

(Supported in part by the Office of Naval Research under Contract Nonr-1834(27).)

Investigations of the properties of bilateral switching networks are being conducted. Threshold logic has been chosen as the simplest functional form for the elements of such networks, and an analysis technique based on this choice and using matrices is being refined. An attempt is also being made to define the classes of machines realizable using such networks and to relate these networks to certain classes of more conventional networks. Variation of the functional form associated with the elements is also receiving consideration.

(W. D. Frazer)

PART IV

DATA REDUCTION METHODS

(Supported in part by Contract No. AT(11-1)-1018 of the Atomic Energy Commission.)

1. Pattern Recognition: Programming Studies

For some time a need has existed in this research for a programming language for the efficient description of algorithms for the preprocessing of pictures (i.e., noise cleaning, other standardization aspects, and labelling techniques). The following report

> Report No. 132, "A Programming Language for the Parallel Processing of Pictures," by R. Narasimhan, January 9, 1963

introduces a set of formal processing macro-instructions for the PAU (Pattern Articulation Unit) and extends Algol 60 programming notation to the parallel picture processing area.

An interpreter for (a variant of) the programming language defined in Report No. 132 has been written for the IBM 7090. A first manual has been prepared and is available as the following File Number:

> File No. 513, "PAX, An IBM 7090 Program to Simulate a General Purpose Pattern Recognition Computer," by James H. Stein, January 24, 1963.

2. The High Resolution Oscilloscopic System

The following file note has been issued:

> File No. 494, "Testing the High Resolution Oscilloscope without Use of a Special Instruction Register," by M. Shirazi, November 2, 1962.

The oscilloscope now properly generates digitally a TV raster, but minor maintenance difficulties still arise and must be traced down. In particular a current discontinuity in the output of the dynamic focus correction current amplifier was detected and appropriate modifications made.

3. Circuit Design

Stability of the generic flipflop of the stalactites in the iterative array is under continuing study. This circuit would be used approximately 12,000 times in the construction of the PAU--and accordingly every attention is being given to stability of operation. The following File Number has been issued:

> File No. 503, "Flipflop Stability Test Report--Three-Flipflop Model," by Dennis Hall, January 30, 1963.

Preliminary design and test evaluation of a universal type of cable driver, cable terminator pair has been completed by Professor Yamada. A file memoranda reference will be given next month. Dr. Yamada has also completed Part I of the design of a computer-controlled test console for D. C. and pulse evaluation of individual semi-conductor elements, as well as printed-circuit boards.

(B. H. McCormick)

PART V

IBM 7090-1401 SYSTEM

(Supported in part by the National Science Foundation under Grant NSF-GP-700.)

During the month of January, 50 new problem specifications were submitted for the IBM 7090.

178-31001T Agricultural Education. Predicting Effectiveness in Student Teaching. This research was undertaken to identify selected predictor items, groups of predictor items, or both, that could be used in the prediction of probable effectiveness of student teachers in Agricultural Education, and expected behavior patterns of these student teachers.

Means and standard deviations of responses by head teacher trainers, as obtained on a survey of significant behaviors of effective student teachers, were computed to aid in the identification of student teaching effectiveness. Just prior to the start of their student teaching experience, students completed a questionnaire designed to collect data concerning their background, interest, personality, and attitude. This information was used to compute twelve factor scores, three for each area, based on the results of a quartermax factor analysis. Evaluations of effectiveness and behavior patterns exhibited were obtained for these students during student teaching.

The final phase of the study, the part in which the 7090 was used, consisted of the computation of multiple regression correlations, with corresponding BETA weights, for the twelve factor scores and the evaluations of the student teaching effectiveness obtained for the students, and the measurements of behavior patterns for these same students. This data was used to identify the factor scores that could be used in predictions and also the importance of each factor score.

179-31002T Psychology. Differential Sources of Rating Bias. This study is designed to investigate possible differential sources of bias in three types of rating techniques--forced choice and graphic ratings by supervisors and leadership nominations by peers. Personnel of two Districts of the Illinois State Highway Police have been rated using all three methods, for each of two successive rating periods. In addition, a number of demographic and ability variables have been obtained for these personnel. Using the rating methods as criterion measures and the demographic and ability measures as predictors, canonical correlational analyses will be run on the computer. Canonical

weights will be obtained for both predictor and criterion variables for all possible canonical variates, in order to determine the relative contributions of each of the predictor and criterion scores to the overall relationships between the two sets of variables. Four sets of canonical analyses will be run, one for each of the two Districts, for each of the two rating periods.

The results of the canonical analyses thus obtained can then be compared with results obtained from computing a number of separate multiple regressions -- one for each of the criterion variables, as well as with the results of factoring the predictors and criteria separately and then combined in one factor-analytic design.

Thus, the computer is needed to compute the canonical analyses, multiple regressions, principal components factor analyses and varimax orthogonal rotations.

180-31003 Digital Computer Laboratory. Knight's Tours. A classical problem of combinational mathematics is that of the knight's tour, which is a sequence of moves by the chess knight such that he lands once and only once on every square of a rectangular board. Although this problem has been examined extensively by many mathematicians, including Euler and Lagrange, very little general knowledge about the existence of solutions obtains today.

It is desired to find the number of solutions for rectangular chess-boards of arbitrary size and shape, and to ascertain the effect of the constraints of closedness and symmetry of tours upon this number.

One can show that the number N of solutions, for a given board and system of constraints, is given by a formula of the type

$$N = n! - C_1 + C_2 - \dots \mp C_n$$

where $C_i = \frac{n!}{n^i} \sum (b_{k_1})(b_{k_2})(b_{k_3})\dots(b_{k_i})$, the summation being over all combinations of $k_1, k_2, \dots, k_i$ within the range 0 to n. $b_0, b_1, \dots, b_n$ are integers.

In order to find exact values for N, it will first be necessary to write a general purpose program to manipulate integers of arbitrary size.

181-31004 Education. Analysis of Classroom Teacher Behavior. This study involves the comparison of twenty-one elementary classroom teachers as they

are engaged in their typical daily classroom pupil-teacher transactions. Component scores have been computed for the twenty-one teachers. The present work will be concerned with correlating these component scores with coefficients of "effectiveness" with regard to eight target pupil variables. The coefficients of "effectiveness" have already been computed.

182-31005T Civil Engineering. Axially Symmetric Wave Propagation Problem. An axially symmetric, elastic half-space is discretized on a rectangular grid network into masses, springs and shear elements. A loading pattern is applied to the surface masses. The resulting accelerations are calculated by Newton's Law; the velocities and displacements are determined by a step-wise integration technique. From the displacements, strains and stresses are defined by the theory of elasticity. By repeated determinations of accelerations and displacements of the masses and the stresses in the springs with increasing time intervals, a stress wave is propagated in the medium.

The effects of discontinuities in the medium, and the dependence of material parameters and integration time intervals on the computational procedure, including stability limits are to be studied.

The IBM 7090 is required to perform the iterative integrations and to calculate the stresses at each grid point during every integration time interval. Because of the many time intervals required in a wave propagation problem in a discretized system, the automatic digital computer is an indispensable tool for the study of the above problem.

183-31006T University of California Lawrence Radiation Laboratory. Spark Chamber Data Reduction. The 7090 is to be used to develope a system program for a spark chamber experiment whose purpose is to measure the π-π mass spectrum in the range of .28 to 1.5 Bev.

The system will contain the following basic parts: individual film measurements transformed through optical distortions into real space, individual spark chamber tracks combined to form the appropriate event pattern, orbits through a three dimensional magnetic field grid, and least squares fitting of tragectories to a specific event hypothesis including the kinematics involved.

184-31007 Education. UICSM Data Analysis. The purpose of this project is to assess the degree of mathematical proficiency (specifically, in the field of algebra) achieved by high school students taught the UICSM First Course, as compared to that achieved by high school students taught conventional courses. The information thus gained will constitute part of the results of a broader evaluation program aimed at studying the extent to which the UICSM courses are fulfilling their educational objectives.

Since the testing has to be done in actual classroom situations, there will inevitably exist discrepancies in intellectual ability levels between different classes. Consequently, in order that the comparison between UICSM and conventional classes be valid, statistical adjustments must be made on the achievement test scores. The technique of covariance analysis is suitable for this purpose.

For carrying out a covariance analysis with more than one concomitant variable (measures of general ability), it is necessary to invert several sum-of-products matrices and further to evaluate several associated quadratic forms. It is evident, therefore, that the IBM 7090 will greatly facilitate the computations.

185-31008T Psychology. Fluid and Chrystallized Intelligence. The purpose of this research is to discover the difference and the relationships between intelligence derived from the culture and intelligence due to innate abilities. Groups of children and adults were tested and the results will be factor analyzed. This procedure involves: correlations, centroid factors, analytic rotations, and visual rotations.

186-31010 Psychology. Empirical Verification of Oblique Simple Structure Factor Analysis Through Use of Physical Models. The intention is to demonstrate the validity of factor analysis methodology by utilizing models whose structures, in terms of casual relationships, etc., are known. The methods used will be correlations, centroid factors, analytic rotations, and visual rotations.

187-31011T Mechanical Engineering. Rotating Isothermal Disc. To study the validity of the Navier Stokes and Energy equations in slip flow it is highly desirable to use an arrangement where the equations can be approximately solved.

One highly advantageous system to use is that of a rotating isothermal

disk; here the flow characteristics, i.e. velocity and thermal boundary layers, may be changed by increasing the disk speed.

In order to test the feasibility of a numerical solution of the above equations in slip flow, i.e. in a rarified gas, the solution will first be attempted in a continuum.

These equations for the flow within the boundary layer of this disk arrangement are:

$$H'''(S) = A\,H\,(S)\,H''\,(S) - \frac{A}{2}\,(H'(S))^2 + 2A^3G^2\,(S)$$

$$G'''(S) = A\left\{H(S)\,G''(S) - G(S)\,H''(S)\right\}$$

$$\Theta''(S) = PrA\,H\,(S)\,\Theta'\,(S).$$

Here, Pr, denotes the Prundtl number and the primes represent differentiation with respect to the independent variable, S.

A - Speed parameter constant for a given speed, hence, for a given approximate solution.

H(S) - Non-dimensional axial velocity

G(S) - Non-dimensional tangential velocity.

S - Space coordinate.

For the continuum attempt the initial and final boundary conditions are:

$H(0) = 0$	$G(\infty) = 0$
$G(0) = 1$	$H(\infty) = 0$
$H'(0) = 0$	$H'(\infty) = 0$
$\Theta(0) = 1$	$\Theta(\infty) = 0$

The Runge-Kutta method is to be used for the solution of the equations.

188-31012 Chemistry. Chemical Kinetics. This research involves the calculation of transmission coefficients in absolute rate theory. The difference equation method will be used to solve some partical differential equations.

189-31013 Civil Engineering. Dynamic Response; Single Degree of Freedom System. This problem is prepared to determine the dynamic response of any single degree of freedom structural system characterized by any bilinear or elasto-plastic resistance-displacement relationship and subjected to any form of base or mass motion or to any external time dependent forcing function.

The parameters of type and amount of damping, frequencies, and resistance characteristics are fixed for a given solution.

The IBM 7090 is used to solve the classical differential equations of motion by various numerical integration techniques.

190-31014T Electrical Engineering. Propagation Along Modulated Periodic Structures. The purpose of this work is to solve the determinantal equation for the propagation constant β of a class of modulated periodic structures. The equation which is of the type $f(\beta, k) = 0$, will be solved for various values of the parameter k- the free space propagation constant. The function $f(\beta, k)$ is a sum of products and ratios of infinite products and is a complex function of β and k.

The problem may be formulated in a program which simultaneously seeks the zeros of the real and imaginary parts of f in an iterative manner. For these purposes the behaviors of f will be studied in addition to finding its zeros. The present formulation will therefore evaluate $f(\beta, k)$ as a function of complex β and the parameter k. The zeros may then be obtained by interpolation.

The operations are to be performed in complex arithmetic throughout.

191-31015 Psychology. Adult and Child Objective-Test Battery. The purpose of this research problem is to build up a multi-factor battery of tests (objective measures of personality) to be used with adults and children.

The method of analysis, in general, is to integrate the results of a series of previous analyses. This integration will involve the selection of tests and items within tests. Statistical procedures will include factor analysis, multiple correlation and multiple regression.

192-31016 Psychology. Motivation and School Performance. An attempt at predicting school performance using a variety of tests of ability, personality, motivation and interest will be made. Hence, the research will involve developing and improving measures of motivation interest and conflict.

193-31017 Psychology. Italian Genetic Study. This is a study to determine the relationship between blood-types and personality factors. 500 subjects of Italion descent were tested on the Personality Factor Test, and then for blood-types.

The method used to determine the relationship will be analysis of co-variance. IBM 7090 routines used will be matrix multiplication, addition, and subtraction.

194-31018 Mechanical Engineering. Boundary Layers in Radiating Media. A problem in boundary layer theory has been formulated which accounts in an exact manner for the emission and absorption of radiant energy by a flowing fluid. Until now, no such solution has appeared in the literature and the results of this investigation not only will provide significant results for the system under study but provide valuable insight into radiating boundary larger flows in situations where the method here used is not applicable.

The result of the analysis is a second order non-linear differential equation with variable coefficients. The most significant result of the analysis is the effect of various parameters on the heat transfer. To obtain heat transfer results the differential equation must be integrated. Unfortunately, the two known boundary conditions are not both initial conditions. Thus, a program must be developed to solve a two end-point non-linear differential equation. It is intended to use a Milne type numerical integration with a Runge-Kutla starting procedure and an iteration scheme to determine the unknown initial condition. This unknown initial condition is intimately related to the basic parameter of interest, the heat transfer.

195-31019 Institute of Communications Research. Person Perception. A form of the semantic differential for use in the measurement of personality has been developed. This instrument, the personality differential, should prove a fruitful tool for the investigation of interpersonal perception. One purpose of the present project is the investigation of the relations among several existing methods for the study of person perception, in particular the location of the personality differential within this network of methodolgies. Other approaches available for the investigation of individual differences in perception are G. A. Kelly's Repertory Test, multidimensional scaling with persons as stimuli, and multidimensional scaling with traits as stimuli. Each of these will be compared with the personality differential approach.

In addition to the relations among these methods an investigation is planned of the determinants or correlates of individual differences in interpersonal perception. Three types of perceiver characteristics will be studied:

general personality traits, the perceiver's system of values, and the "cognitive styles" of the perceiver.

In this research several standard routines will be used such as matrix multiplication, latent roots and vectors, correlations, Varimax rotations, etc. In addition, programs for multidimensional scaling are to be used. Some of these have been developed at other universities and will be altered for use in these studies.

196-31020 Psychology. Vector Model for Color Sensations. The purpose of the research is to derive a vector model for color sensations to be based on four assumptions: Every color sensation may be represented by an origin-bound vector in three-space, the value of the sensation may be represented by the length of the vector, the chromaticness (hue and saturation) of the sensation may be represented by the direction of the vector, and the sensation evoked by the physical mixture of two or more sets of radiations may be represented by the vector sum, or resultant, of the vectors representing the sensations of the component colors--so that the rule for the combination of color sensations is identical with that for the combination of forces in mechanics. A least squares solution is sought for the best mappings combining color mixture data and luminance data.

197-31021 Psychology. Elementary Cipher. A program is to be run in order to produce a cipher on the 7090. The standard input-output equipment Hollerith codes are used to read in the text to be coded, and to print the the coded text. Once in the machine, the text is converted from the core Hollerith code to a special code, and is flipped binary bit-wise according to a mark or keyword. This results in coded text in the special internal alphabet which is then converted to core Hollerith and output.

An interesting feature of this cipher is that the same program is used for encoding and decoding.

198-31022 Digital Computer Laboratory. Labeling Algorithm. The Simulator, written to simulate the Pattern Articulation Unit of the pattern recognition computer currently being designed will be employed to refine various pattern labelling algorithmns.

199-31023 Education. Comparison of Intellectual Changes. Approximately 25 tests of intellectual abilities have been administered to ninth graders about to begin the study of algebra using the UICSM materials and to other ninth graders about to begin using other texts. The correlations between these tests and between these and subject matter mastery tests will be factor-analyzed.

The same two populations will be tested (different samples) at the close of the year and those correlations will also be factor analyzed. Interest will center on changes, within each population, of the factorial structure between pre-instruction and post-instruction performance; a change which occurs in both populations will be attributed to maturation or the effects of the year's study, a change which occurs in only one population will be attributed to the unique characteristics of that method of teaching algebra. Sex differences will also be investigated.

The statistical calculations required will include the computation of all of the intercorrelations in the study, extraction of factors from at least two correlation matrices (principal components method preferred, centroid acceptable), and several item analyses.

200-31024T Psychology. Test Score Intercorrelations. This research problem involves the intercorrelation of twelve variables relating to juvenile delinquency proneness and other personality characteristics of youths, in the form of test scores and ratings, for 92 subjects. The IBM 7090 will be used to perform the intercorrelations of the variables for the subjects.

201-31026T Electrical Engineering. Layered Medium Secular Equation. This routine will solve for the roots of the secular equation for the propagation constants in a two dimensional layer medium.

202-31027T Mechanical Engineering. Cavity Stanton Number. The overall problem is concerned with determining the heat transfer coefficient for the situation of a gas flowing past a cavity in an otherwise flat plate.

The digital computer will be used to solve a second order, ordinary differential equation with variable coefficients. The method of solution will be a standard form of Runge-Kutta integration.

203-31028T Civil Engineering. Propagation of Aerotriangulation Error. The study of the propagation of error in aerotriangulated strips of aerial photography is very basic in the determination of accuracies obtained with various methods of aerotriangulation. Two types of error are involved (systematic and accidental).

To study the nature of the effects of these errors, a program will be written to compute strip coordinates as affected by the intruduction of fictitious data (error) in the elements of relative orientation.

The 7090 is suitable and necessary in such a study because of the very large amount of repetitive computation involved.

204-31029T Mechanical Engineering. Reattached Boundary Layer. This problem is the solving of a pair of simultaneous first order differential equations for form factors and momentum defect thickness. A solution will be obtained by using the first few terms of Taylors series.

205-31030 Physics. Solenoid Problem. The complete equation for the time necessary for a solenoid to throw a given distance is unsolvable in its present differential form. The 7090 will enable the solution of this equation using iterative methods. Present solutions are accurate to 50 per cent. Therefore the solutions have previously been found by costly model building.

206-31031T Chemical Engineering. Harmonic Analysis. This research is a dynamic analysis of a chemical reactor. The input is approximately sinusoidal and this program will be used to check the response. Outputs of the system will be non-linear waves which must be subjected to a harmonic analysis for meaningful results about the nature of the system describing function.

The program, a harmonic analysis, computes the coefficients of the Fourier Series which describes the input data.

207-31032 Agronomy. Analysis of Soil Experiment Field Data. There are approximately 30 soil experiment fields at various locations in the State of Illinois. Long term crop rotation and fertilizer practices studies have been carried on at each of these fields since 1910.

Analysis of variance procedures will be used to investigate differences between fertility practices and the long term trends in crop yields for the various rotations and fertility practices.

Appropriate analysis of variance programs have been written. The analysis is essentially that of a factorial experiment in which the factors are time, crop, and fertility practices.

208-31033 Physics. Nuclear Reaction Cross Section Calculation. A great many experiments performed with the University of Illinois cyclotron are designed to permit measurements of nuclear reaction cross sections. The extraction of these cross sections from the raw reaction data is a tedious and lengthy task, even though the mathematical techniques involved are rather elementary. Since recently acquired equipment provides raw data at a much faster rate than was possible previously, the extraction of cross sections from the data will be a major bottle neck in the analysis of cyclotron experiments.

The IBM 7090 computer provides an excellent method for calculating cross sections accurately and inexpensively. Its use will make cross section data analysis the simplest part of reaction data processing instead of the most tedious.

The actual quantities which the cross section calculation program will compute are laboratory cross sections, transformations (for angles and cross sections) from laboratory to center of mass systems, cross section corrections for background, overlap, multiple scattering, and target angle effects, Rutherford scattering cross sections for elastic scattering experiments, statistical errors, and total errors.

209-31034 Mechanical Engineering. Air Conduction Temperature Profiles. This problem involves the calculation of temperature profiles in a slab of air bounded by constant temperature walls. Account is taken of the variation of the thermal conductivity of air with temperature. Three different relationships between temperature and thermal conductivity are used and five combinations of boundary temperatures are used.

210-31035 Physics. Programs to Play Games. The problem is to devise programs that enable the computer to play certain games. Examples of such games whose natures make them adaptable to computer programs are: Three-

dimensional Tic-Tac-Toe played in a cube of sixty-four boxes, other Tic-Tac-Toe games of varying complexity, nim, and checkers.

The first problem, the Tic-Tac-Toe game, will be approached according to the following plan.

First a language, or code, will be devised in which the machine will operate and with the aid of which data pertinent to the game may be introduced into the machine. For example, a move may be coded by using a six bit binary number. The number consists of three groups of two binary digits each, each group representing the x, y, or z coordinates of the box in which the move was made.

Then the game will be analyzed to determine its mathematical basis. For example, the problem of determining the mathematical characteristic of a winning line of four boxes will be studied.

Since the total number of possibilities in the game is too great to be completely studied, certain general rules will be formulated according to which the computer will choose moves. A random element may be employed also so that the computer does not always make the same move in a given position.

In addition, a learning feature may be employed whereby the computer analyzes past games to determine which moves were favorable and which unfavorable. The computer will use the results of such analyses to make decisions in later games.

211-31036 Electrical Engineering. Parameter Study. High intensity ultrasound produces changes of a selective nature in tissue. An extensive study of the dosage relations to produce a given functional endpoint on ultrasonic irradiation of a portion of the spinal cord has been in progress for a number of years. These quantitative relations are determined as a function of various physical parameters including the sound level and its duration, the base temperature of the tissue, and the frequency of the radiation. A sufficient quantity of data has now been obtained to provide a basis for comparison with a quantitative theory of the mechanism of the action of the sound. The relations for which computations are required constitute a theoretical description of both threshold values and the variation of the required duration as a function of sound level to induce the observed changes. By comparison of the experimentally observed

relations with a family of computed curves - computed for different sets of values of the "constants" of the relations, - it is expected that one can not only check the validity of the theory but also evaluate these constants.

212-31037 Mechanical Engineering. Laminar Flow Development. The problem is a description of the succession of velocity profiles in the development region of a circular tube, along with the pressure differences from the origin of the tube; based upon a somewhat simplified form of the Navier-Stokes equations. Although many attempts for a solution in this region have been attempted all attempts fall short of full agreement with experiment, the commonest simplifications usually employed giving results half those obtained experimentally using boundary layer techniques.

In the present approach the problem is treated by the method of finite differences for the first unknown, the velocity profile, and an iterative procedure is employed at each step to determine the second unknown, the pressure gradient over that interval.

213-31038 Mechanical Engineering. Ejector Mixing. This possibility of a choking phenomenon occurring in two dimensional boundary layer scoops for expanding flows requires the calculation of the area ratio for the flow under a wide variety of flow conditions and geometries. This assumption of a power profile allows integration of the scoop boundary layer. Thus, the downstream conditions may be compared with the approaching boundary layer and inspected for a minimum area choking condition.

214-31039 Psychology. Computer Assistantship Study. This problem specification will be used exclusively for the testing and study of various subroutines and programs as well as the FORTRAN system itself. This will be done in connection with the work of the computer teaching assistant in psychology. Work in connection with specific projects will continue to be done under other problem specifications.

215-31040T Education. NDEA Institute Data Analysis. The purpose of this study is to analyze objective and subjective data obtained on 452 counselor

trainees enrolled in 15 NDEA Counseling and Guidance Training Institutes. The initial analysis is for the purpose of locating factors derived from the objective measures common to this population. The objective data consists of 104 raw scores obtained from sub-scales of seven standardized tests administered to each of the 452 counselor trainees. This objective data was secured prior to the beginning of the formal instructional program within each Institute.

The intercorrelations of the 104 objective measures will be analyzed by means of a component analysis. The 7090 will be utilized to provide this analysis. The programs to be employed will be principal axes factor analysis with Kaiser's Varimax rotation. Component analysis was selected to serve two purposes: To reduce the number of variables and in order that component scores can be computed directly for use in further analysis.

The component scores derived from the above described analysis will be related to seven objective raw scores and two subjective measures. The seven objective scores are obtained from a standardized instrument administered after completion of the Institute program. The two subjective measures are Institute grade point average and a global rating of predicted success as school counselors. This prediction was made by NDEA Institute staff members in relation to their own Institute trainees.

216-31041 Theoretical and Applied Mechanics. Determination of a Metal's Endurance Limit by Prot's Method. The Prot Method of determining the endurance limit of a material may be outlined as follows. A standard specimen is loaded with a given initial stress S_o and as a repeated load is applied this initial stress is increased at a given rate α. When the specimen fails the rupture stress S_R and the number of cycles N of the repeated load is recorded. This test is repeated M times varying α and possibly the initial stress S_o.

Having obtained the values of α, S_R, and N a plot of S_R versus α^n is made so that an equation of the form

$$S_R = S_e + K\alpha^n$$

is obtained. Since in general this plot will not be a straight line and the points will be "scattered" because of specimen differences and experimental

errors, the method of least squares is applied to obtain S_e, K, n in the above.

$$\sum_{i=1}^{M} (S_{R_A} - S_{R_{(1)}})^2 = \text{minimum}$$

where S_{R_A} is the observed rupture stress and $S_{R_{(1)}}$ is the rupture stress. Satisfying these requirements results in three non-linear algebraic equations in S_e, K, n which are solved using the Newton-Raphson method. The final result desired is S_e, the endurance limit.

Using the results obtained as outlined above, standard statistical methods are used to find the probable error in the result obtained for S_e.

217-31042T Chemistry. Molecular Orbital Calculations. The purpose is to study properties of some simple transition metal halides by simplified quantum mechanical methods. First a calculation of self-consistent wave functions using a Hartree-Fock scheme will be carried out by numerically solving a set of linear second order differential equations. The multi-dimensional molecular integrals involved will be approximated by the Monte Carlo method or numerical quadratures (the Monte Carlo method will be tried first). To test the method, the simplest molecular H_2 would be tried first.

218-31043 Mechanical Engineering. Free Convection Heat Transfer. In a recent publication it has been shown that exact solutions to the pertinent equations of momentum and energy governing the flow and energy transfer in the vicinity of a non-isothermal vertical cone can be obtained. The results obtained are important as they provide solutions to the particular problem under study and also provide results to which approximate methods of solution may be compared insofar as accuracy and labor are concerned.

The results of the analysis are two simultaneous non-linear differential equations with two point boundary conditions. The most important results obtained by solving these equations are the heat transfer and wall shear stress. Both of these quantities are directly related to the unknown initial conditions. A program is being developed to iterate on the solutions of the differential equations for different sets of estimated initial conditions. These estimated or approximate initial values were obtained by the use of the aforementioned approximate boundary layer techniques. From previous experience with a similar program, convergence of the iteration on the unknown

initial conditions is assured. The integration technique utilized in the program is a technique using both Runge-Kutta and Milne type difference formulas developed previously.

219-31044 Music. Guitar Picks. The purpose of the problem is to find all the different possible guitar picks which may be used. This will be done with four loops which find all combinations of numbers from one through seven (for example 1111 through 7777, in octal) and assigns these numbers to seven different basic picks from which the final combinations will be made.

The seven basic picks are (T) (this means thumb) (T 1) (T 2) (T + 1) (T + 1 2) (T + 2 1). One means first finger, and 2 means second finger. As the picks are formed, they are tested, and those which are worthless are thrown out.

220-31045 Civil Engineering. Buckling of a Cylinder. A parameter study of an expression for the buckling load of an axially loaded, stiffened cylinder will be made.

221-31047 Institute of Communications Research. Cognitive Structure of Voters. Four hundred interviews were collected in each of three time periods before, during, and after a congressional campaign. These interviews elicited sociological data on each of the respondents, their preferences for party and candidate, their perception of how each candidate stood on a number of issues, and reactions to those stands.

Standard library programs will be used for ascertaining association of voter characteristics with perception of candidates and issues, structure of issues, and changes in these. A panel design with controls for sensitization was used.

222-31048 Mining, Metallurgy and Petroleum Engineering. Sedimentation Rate. The repetitive calculation of e^{-x} and

$$\frac{5}{2} x^{-3/2} e^{-x^{5/2}}$$

is necessary in order to correlate the thickness of varves in clay to the distance from the sediment source. This arises in connection with a study on sediment deposition in ocean basins.

223-31049 Theoretical and Applied Mechanics. A Mass Supported by a Spring-Dashpot Moving Across A Simple Beam. The purpose of this study is to investigate the behavior of a simple supported beam which is loaded by a point mass. Between the point mass and the beam a spring in parallel with a viscous dashpot is placed.

The equations of motion which arise from this problem are two coupled linear integral equations of the type

$$\int_0^t F\,[\ddot{S}\,(\tau),\ \ddot{\underline{\bar{Y}}}\,(\tau)]\,d\tau = f\,(t)$$

$$\int_0^t G\,[\ddot{S}\,(\tau),\ \ddot{\underline{\bar{Y}}}\,(\tau)]\,d\tau = g\,(t)$$

where

t = time

S = beam displacement

$\underline{\bar{Y}}$ = mass displacement

F,G,f,g = known functions of time.

Using a suitable quadrative formula such as the trapezoidal rule on Filon's method, the integrals are replaced by finite sums and the resulting algebraic equation is solved for $\ddot{S}$ and $\ddot{\underline{\bar{Y}}}$. Integrating these results twice results in S and $\underline{\bar{Y}}$, the final results. The integral equations are recursive in character and make use of previous results obtained. Therefore the inversion of a matrix is not necessary.

224-31050T Civil Engineering. Compaction Characteristics of Tropical Soils. Tropical soils play an important part in the expanding construction activity of several countries of the world. It is of paramount importance that the soils engineer engaged with such activity not only have some idea of the origin and distribution, but also of the engineering properties as well as the compaction characteristics of tropical soils both in the laboratory and in the field.

Statistical analysis is necessary for obtaining correlations between laboratory and field compaction variables, and in order to draw conclusions or make inferences of compaction characteristics from correlation analyses, linear and multiple regressions, etc.

225-31051T Chemistry. Entrance Effects in Tubular Reactors. This program is part of an analytical study of simultaneously developing concentration and velocity profiles in the entrance region of a tubular reactor. The IBM 7090 will be used to obtain numerical solutions to the laminar flow transport equations for this system.

226-31052T Agricultural Economics. Study of Agricultural Production Functions. Multiple Regression Analyses will be used for the study of and fitting of numerous agricultural production functions.

227-31053T Chemestry. Application of Entropy in the Correlation of Frequency Spectra. Frequency spectra constitute an important part of turbulent flow data. At present there exists no method to compare the spectra of different flow systems (i.e., pipe flow, waves, etc.) or even to compare those of different flow conditions within a particular system. The utilization of the entropy is an attempt to alleviate this deficiency.

The relative degree of randomness of a process may be expressed by the entropy. The entropy H given as,

$$H = \int_0^{\infty} f(n) \ln f(n)\, dn$$

is a maximum when the function f(n) of the continuous variable n is a Maxwellian distribution. A value of entropy can therefore be calculated for an experimentally determined frequency spectra, and subsequently compared to the entropies of other spectra and to the Maxwellian distribution having the same total energy.

For this problem the variable n becomes the frequency and f(n) the spectral density function. Data, in the form of a table containing f(n) as a function of n will be the input. The linear interpolation subroutine will be used to get a first order interpolation of the data.

The spectral density function must first be normalized with respect to the total energy,

$$\int_0^{\infty} f(n)\, dn$$

The integration is to be carried out, using the trapezoidal rule. The normalized function,

$$\bar{f}(n) = f(n) \Big/ \int_0^{\infty} f(n)\,dn$$

is then used in the calculation of the integrand in the expression for the entropy.

Summaries of the operation of and the use of the IBM 1401 and the IBM 7090 are given in the following tables.

Table I-1401 shows the distribution of IBM 1401 time during the month of January.

TABLE I-1401

Scheduled Engineering	5:10
Unscheduled Engineering	4:37
Air Conditioning	5:40
7090 Preparation	230:36
Tape Labeling	3:20
Deck Reproduction	4:37
Listing	16:28
Code Checking	7:56
Illiac II Code Checking	2:17
Tape Testing	36:21
CDC Preparation	8:53
Statistical Service Unit	:08
Idle	61:27
Wasted	:43
	388:13

Information on running time, wastage, scheduled engineering, unscheduled engineering and machine errors for the IBM 1401 is given for each day of the month of January in Table III-1401. The errors and their sources are summarized in Table II-1401.

TABLE II-1401

729V Tape Units	4
1402 Reader-Punch	2
1403 Printer	2
	8

JANUARY, 1963 - TABLE III - IBM 1401 DAILY TIME DISTRIBUTION

DATE	RUN OK TIME	SCHED. ENGIN.	UNSCHED. ENGIN.	IDLE	WASTED	AIR COND. MAIN.	TOTAL RUN TIME	ERRORS	
1-2-63	15:28			:45			16:13		(1) Tape unit 'B' did not come out of high speed rewind.
1-3-63	11:50	1:25		4:30			17:45	2	(1) Tape unit 'A' did not come out of high speed rewind. (2) Tape unit 'A' off-line. Above situation corrected during the scheduled engineering.
1-4-63	17:59			:20		5:40	23:59		
1-5-63	:45						:45		
1-7-63	20:30			1:00			21:30		
1-8-63	21:44						21:44		
1-9-63	17:00		:15	1:35			18:50	1	(1) Constant reader checks on 1402 reader. Replaced two bad brushes.
1-10-63	17:52		1:40	:20	:13		20:05	1	(1) Constant punch errors in 1402 punch. Punch brushes were not down.
1-11-63	9:45		:30	5:35	:30		16:20	1	(1) 1403 printer "End of form" light keeps coming on. Form tracker pressure plate was loose.
1-14-63	14:15			2:25			16:40		
1-15-63	14:20		:30	3:15			18:05		
1-16-63	23:35			:25			24:00		
1-17-63	14:46			3:25			17:11		
1-18-63	15:55			2:20			18:15		
1-21-63	4:57			9:03			14:00		
1-22-63	6:53	1:30		5:37			14:00		
1-23-63	9:41		:07	4:12			14:00	1	(1) Fuse blown on tape unit 'A'.
1-24-63	4:25	2:15		7:20			14:00		
1-25-63	12:15			3:45			16:00		
1-28-63	14:27			1:30			15:57		
1-29-63	14:56			2:00			16:56		
1-30-63	13:40			2:20			16:00		
1-31-63	13:38		1:35	:45			15:58	1	(1) Main shaft on 1403 carriage creeps forward. Trouble not found.
	310:36	5:10	4:37	61:27	:43	5:40	388:13	8	

Table I-7090 (January) shows the distribution of IBM 7090 time during the month of January.

TABLE I-IBM 7090
January

Scheduled Engineering		169:51
Unscheduled Engineering		33:36
Air Conditioning		15:50
Idle		75:38
		294:55
System Updating		6:21
Production (See Table IV)		140:27
	TOTAL	441:43

Table II-7090 (January) summarizes the information on maintenance time spent on the IBM 7090 and its associated equipment during the month of January.

TABLE II - 7090

716 Printer		2
729VI Tape Units		5
Arithmetic Unit		4
Air Conditioning		1
Data Channels		1
	TOTAL ERRORS	13

TABLE III - IBM 7090 DAILY TIME DISTRIBUTION - JANUARY, 1963

DATE	OK RUN TIME	SCHED. ENG.	UNSCHED. ENG.	IDLE	WASTED	AIR COND.	TOTALS	ERRORS	
1-2-63	7:43	1:00	1:00	6:02			15:45	1	(1) Worked on 716 clock - found nothing wrong.
1-3-63	3:34	1:10	:20	3:41		7:15	16:00	1	(1) Attached amplifier and speaker to IBM 7090.
1-4-63	6:22			1:03		8:35	16:00	1	(1) Air conditioning maintenance.
1-7-63	9:55	1:00		5:31			16:26		
1-8-63	9:43	:40		5:52			16:15		
1-9-63	10:09	1:00	1:50	2:56			15:55	1	(1) Channel 'A' failed to disconnect after a rewind.
1-10-63	7:25	:30	:13	7:50			15:58	1	(1) Control would not return to console.
1-11-63	1:40	1:25	12:45	:10			16:00	1	(1) Bad card in central processing unit.
1-12-63	:50		8:30				9:20	1	(1) Same error as above.
1-14-63	14:43	:50		:37			16:10		
1-15-63	6:34	1:15		8:12			16:01		
1-16-63	10:48	1:45		3:40			16:13	1	(1) Tape unit (AW) taken off line and checked.
1-17-63	11:51	1:30		2:39			16:00		
1-18-63	10:36	2:25	:20	4:11			17:32	1	(1) Tape unit (AU) head down switch failed to sense that head was down.
1-19-63		24:00					24:00		
1-20-63		24:00					24:00		
1-21-63		24:00					24:00		
1-22-63		24:00					24:00		Installation of memory protection feature.
1-23-63		24:00					24:00		
1-24-63		24:00					24:00		
1-25-63	5:54	7:26		:17			13:37		
1-28-63	4:26	1:00	6:00	4:32			15:58	2	(1) Check of 716 printer clock on-line. Found burned points in relay.
1-29-63	7:12	:45		8:39			16:36		(2) Tape unit (BY) taken off-line and checked.
1-30-63	7:51	1:40	2:28	4:01			16:00	1	(1) Tape unit (BY) malfunctioning. Nylon roller was replaced.
1-31-63	9:32	:30	:10	5:45			15:57	1	(1) Checked tape unit (BY) on line. (BY) was put back on line.
TOTALS	146:48	169:51	33:36	75:38	0	15:50	441:43	13	

TABLE IV - IBM 7090 USE BY DEPARTMENTS - JANUARY, 1963

DEPARTMENT	CLASS	RESEARCH	NON-SYSTEM	TOTAL NO. OF RUNS	CLASS	RES.	NON-SYSTEM	TOTAL TIME
Agricultural Engineering		33		33		:49		:49
Agricultural Economics	7	19	18	44	:23	:47	3:44	4:54
Agronomy		85		85		2:11		2:11
Animal Science		4		4		:13		:13
Business Administration		1		1		:01		:01
Civil Engineering	344	464		808	7:07	31:22		38:29
Chemistry	7	394		401	:13	10:46		10:59
Digital Computer Laboratory	1421	345	22	1788	11:45	14:00	14:33	40:18
Economics		27		27		:54		:54
Education		9		9		:13		:13
Electrical Engineering	388	118		506	5:12	2:30		7:42
Institute for Communications Research		1		1		:01		:01
Industrial Engineering	35	22		57	:20	1:05		1:25
Instructional TV		68		68		2:15		2:15
Mathematics		7		7		:14		:14
Mechanical Engineering	91	202		293	:31	3:23		3:54
Mining, Metallurgy and Petroleum Eng.		15		15		:22		:22
MRHAR		1		1		:01		:01
Music		12		12		:09		:09
Nuclear Engineering		7		7		:10		:10
Physics	37	349		386	2:10	12:42		14:52
Psychology		100		100		2:16		2:16
State Geological Survey		9		9		:21		:21
Sociology		7		7		:13		:13
Statistical Service Unit		98		98		3:14		3:14
State Water Survey		63		63		1:12		1:12
Theoretical and Applied Mechanics		90		90		2:15		2:15
Veterinary Anatomy and History		3		3		:01		:01
Veterinary Medical Science		11		11		:49		:49
TOTALS	2330	2564	40	4934	27:41	94:29	18:17	140:27

PART VI

INSTRUCTIONAL USE OF THE IBM 7090-1401 SYSTEM

During the month of January, two problem specifications were submitted.

46-31009 Theoretical and Applied Mechanics 461. Problem 1. The problem is to find interaction curves for rail sections approximated to an I-section. The interaction curves are relations between the load P and the bending moment that the section of the rail can sustain. These curves are drawn for different proportions of the rail sections and for different depths of yielding.

47-31025 Psychology 466. Problem 1. The class in test construction (Psychology 466) has prepared and administered a special form of psychological examination which requires complex scoring procedures. The 7090 is being programmed for this scoring. Further computations will involve intercorrelations of derived scores and other variables.

PART VII

GENERAL LABORATORY INFORMATION

Colloquia

"Alternating Direction Methods for Solving Elliptic Partial Differential Equations," by Professor David M. Young, Jr., University of Texas, January 7, 1963

"The Monte Carlo Method in Classical Statistical Mechanics," by Professor Lloyd D. Fosdick, Digital Computer Laboratory, University of Illinois, January 14, 1963

"Elementary Algebraic Manipulation by Machine," by Dr. C. Y. Lee, Bell Telephone Laboratories, Holmdel, New Jersey, January 21, 1963

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-Time	Full-time Equivalent
Faculty	15	1	15.5
Visiting Faculty	3	0	3.0
Research Associates	6	0	6.0
Graduate Research Assistants	5	30	20.5
Administrative and Clerical	8	0	8.0
Other Nonacademic Personnel	44	31	57.5
TOTAL	81	62	110.5

The Computer Advisory Committee consists of Professors H. C. Brearley, L. D. Fosdick, C. W. Gear, D. B. Gillies, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During January a total of 193 drawings have been processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	3	4
Medium Drawings	2	
Small Drawings	1	10
Miscellaneous	8	
Reports	92	3
Etched Wiring Layouts		9
Change Orders	61	—
	167	26

(J. K. Burrell, K. C. Law)

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM
PART II - CIRCUIT RESEARCH PROGRAM
PART III - SWITCHING THEORY
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FEBRUARY 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction

In terms of transistor counts the following progress has been made during February.

Chassis dc checked	1,704	
Chassis inspected	371	
Chassis wired	531	
Chassis layed out	2,176	
Cards wired	400	(estimated)

2. Component Data

Following is a crude summary of transistor behavior after 4500 to 5000 hours of machine use, taken on a small sample of about 500 transistors of three types.

Change in α at 10 ma		Decrease	No Change	Increase		
Type	Total No.	$< .006v$	$\leq .003v$	$< .006v$	$< .009v$	$< .021v$
2N711A	210		155	55		
S166	286	1	79	188	14	4
GF45011	21		18	3		

Change in Veb at 10 ma		Decrease		No Change	Increase
Type	Total No.	$< .06v$	$< .04v$	$\leq .02v$	
2N711A	210		1	209	
S166	286	1	4	281	
GF45011	21			21	

Change in BVcbv at 100 μa		Decrease		No Change	Increase		
Type	Total No.	*Catastrophic	< 4v	≤ 2v	< 4v	< 6v	< 12v
2N711A	210			210			
S166	286	3	4	245	29	4	1
GF45011	21			21			

Change in BVebo at 100 μa		Decrease		No Change	Increase		
Type	Total No.	< 2v	< 1v	≤ 0.5v	< 1v	< 2v	< 3v
2N711A	210			26	88	84	12
S166	286	1	4	259	16	5	1
GF45011	21			18	3		

* Note that all of the transistors measured were still in operating condition, i.e., they have been removed from an operating chassis. The reverse voltages of the three units noted as catastrophic had decreased from near 40 volts to 2.4 volts, 15 volts and 21 volts.

(B. Doden)

3. Magnetic Drum Memory

A read amplifier front-end using a differential amplifier to convert from the push-pull matrix output to a single-ended signal was designed. The previous circuit used a transformer. The differential amplifier circuit recovered from a 200 millivolt input step in about 40 μsec. This appears to be satisfactory. To achieve this it was necessary to use very much larger capacitors in the emitter network of the second stage than before.

It was observed that at a write current of 175 ma peak-to-peak, the overwriting of previous signals was not quite complete. When a 280-bit-per-inch signal was written over a 35-bit-per-inch signal, the resulting 280-bit-per-inch read voltage had about a 20 per cent 35-bit per-inch component. Increasing the write current and decreasing the write current rise time improved this considerably. The investigation is continuing to determine the optimum operating point.

(M. D. Freedman)

A worst-case design for the row and column drivers was completed. A preliminary block layout of the read-write electronics was made.

Some test procedures for checking the logic chassis of the magnetic drum memory without a drum were developed. Some of these tests were performed. No errors were found other than those mentioned below.

(B. Levy)

All logic has been revised to allow permanent installation of two drum simulator chassis in the drum frame. These will allow the drum interplay channel to be checked independent of the operations of the actual drum.

Ten drum logic chassis and one test chassis, DA1W, were installed in the frame. They were tested and repaired as follows:

1. The dc-power distribution was checked. No errors were found.
2. Memory elements were checked for ability to hold state. The errors were:
   a) Two bad indicator bulbs.
   b) One shorted 1N3018B zener diode.
   c) One 2N706 heat sink shorted to -H4M bus because of too long leads. This destroyed nine 2N1308's.
3. Cable terminations were checked. Two were found missing.
4. Turning on dc power sometimes left N and/or F set to 1. This is a hang-up condition. A circuit was added to clear F to 0 when Reset Alarms, RA, is actuated.

(S. P. Krabbe, L. Byers)

4. Core Memory

A rash of parity errors has been traced to drift and intermittency in commerical supplies used to regulate -25 volts. A complete solution to this problem must await the construction of regulators fed from the center tap of the

-50 volt mag amps. A bad wiper on the strobe delay has also been shown to contribute to intermittent behavior.

A new blower installed beneath the sense amplifiers has reduced hot spot temperatures by about 15°C to about 30°C.

(R. F. Kingsley)

5. New Core Memory

Revised bids for the new memory have been opened. General Ceramics remained low bidder, asking $108,000 for an initial 4,096 words and $48,500 for a subsequent 4,096-word expansion. The first 4,096 words has been ordered with delivery expected in November.

(S. Ray)

6. Special Registers and Interrupt

A systems description has been prepared for distribution as File No. 517.

(D. B. Gillies)

Special registers will be implemented as a generally distributed bus system for ease of future expansion. The central controls, drivers and terminators for the special registers as well as the interrupt logic will occupy one or two modules in the 1401 control cabinet.

(R. Willard)

7. IBM 1401 Interplay Channel

The interplay channel for the 1401 will occupy the eleven racks of one printed-circuit module; each rack is designed to hold up to 30 printed-circuit boards. Intra-rack wiring is completed on three of the eleven racks and logic has been designed and checked on another three racks.

(R. Willard, R. Miller)

Drawings for power supply turn-on have been completed. Regulator modules are about to be constructed by the shop. Detail drawings for interplay channel equipment bays will be complete within a week.

(C. E. Carter)

8. Systems Programming

Three chapters of the new ILLIAC II manual are being typed. These will be available at the end of March. They describe in detail the use of the assembler program which is nearing completion.

(C. W. Gear)

9. Diagnostic Programming

Engineering test of Normalize is now completed and included in ETR. The Matrix Multiplication timing test is completed. Seven methods of multiplication were tried with inner loop times of 14 to 18 μsec as compared to 10 μsec for STRETCH.

A comparison program for matrix multiplication on the IBM 7090 is being written.

(J. Bouknight)

10. 1401 System

Four 729 VI tape units were delivered during the month of February; however, the cables to connect these units to the system did not arrive, and as a result no use has been made of them.

The rest of the system has been in limited use. Such use, of course, has been restricted to work with cards.

A copy of the IBM Engineering Test programs for the 1401 is now available. The preliminary writeup of the routines presently in the 1401 library is now complete.

An 026 card punch has been delivered. It was checked out by the engineers and is now available for use.

(J. Bouknight, W. L. Huffman)

11. <u>Operations</u>

Code Checking		82:28
*Production (Mersenne Primes)		107:06
Engineering Test Routines		
ETR	194:43	
ASMD	18:30	
Duplex Memory	11:32	
OLF	11:47	
Memory Reversing	:28	
Cross Talk	5:00	
		242:00
Engineering and Maintenance		93:42
A.C. Speed-up		38:45
Idle		14:40
TOTAL IN OPERATION		578:41

* Does not necessarily indicate actual time in production. First, code checking time is included in these figures; and second, since no one is present after midnight, an accurate time check of machine operation is not possible.

Errors	
Parity	23
Punch	10
Reader	1
Power Failure	4
TOTAL	38

Bad Components	
Diodes	5
Solder Joints	4
Capacitors	1
Transistors	3
Locked Fan in Core	1
TOTAL	14

(W. L. Huffman)

PART II

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Henry Guckel has been able to prove the stability of his inverting transmission line system using a single tunnel diode in the coupled line. He has also developed a very simple intuitive explanation of the fact that the above system has a high input impedance and a low output impedance.

Gabor Ujhelyi has started work on a simple associative memory using tunnel diodes. The idea is to interrogate a pair of tunnel diodes which are in the 0 and 1 or 1 and 0 state respectively, depending on the information to be stored in the cell. This interrogation is done by increasing the current through one but not through the other by a pair of "key pulses" and observing the variation in output voltage.

Thomas Burnside is designing the last part of the statistical analyzer, i.e., the discriminator circuits which sample the height of the output pulses of a network in which all values of parameters are tried out automatically by electronic switching.

2. Tunnel-Diode Work

Theoretical Work

The stability analysis for s- and n-type non-linearities has been concluded and was summarized in a file report. Stability considerations for the three possible diode terminations of the intercoupled strip line are nearly complete. The single diode case (non-inverting) was shown to be stable. This case has the capability of power amplification. The single diode inverting case is under investigation. The conclusion is therefore that power amplification is still possible. This property is related to the apparent increase of the characteristic impedance of the primary line. The mechanism may be understood by considering the following arguments.

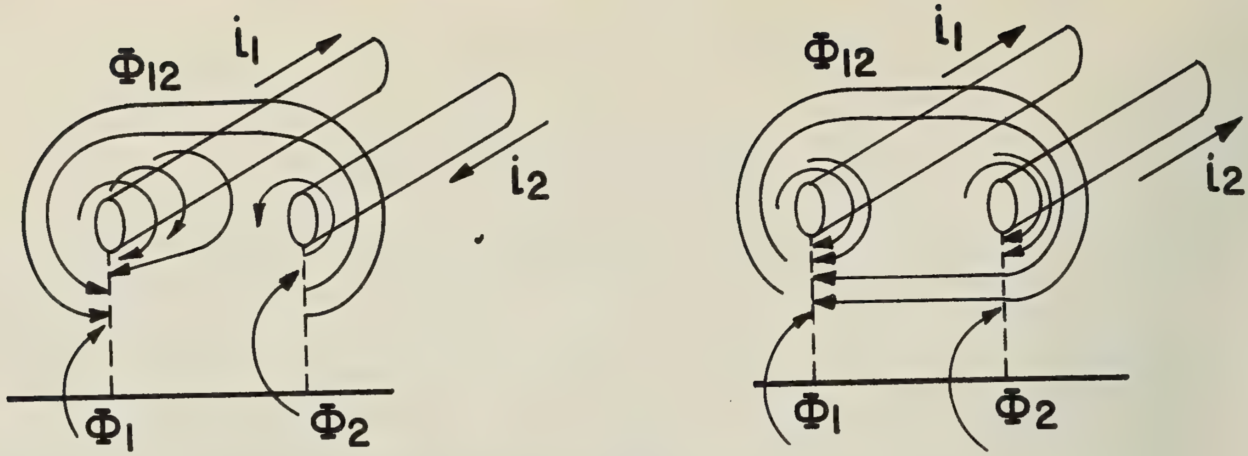

Figure 1. Flux Patterns around Coupled Lines

For the passively coupled case i_1 and the induced i_2 are in opposite directions. Hence:

$$Z_{01} = \left(\frac{L}{C}\right)^{\frac{1}{2}} = K\left(\frac{\phi_1 - \phi_{12}}{C}\right)^{\frac{1}{2}} < Z_{01}(\phi_{12} = 0)$$

In the actively coupled situation the sign of ϕ_{12} is changed, since i_1 and i_2 may have the same direction:

$$Z_{01} = K\left(\frac{\phi_1 + \phi_{12}}{C}\right)^{\frac{1}{2}} > Z_{01}(\phi_{12} = 0)$$

and since Z_{02} may be assumed to be the same in both cases:

$$Z_{02} = K'\left(\frac{\phi_2 + \phi_{12}}{C}\right)^{\frac{1}{2}}$$

A transformation from a high to a low impedance takes place. If the system exhibits an equal to or better than unity voltage transfer, power gain is implied. In a sense then the secondary propagation modulates the effective characteristic impedance of the primary.

Experimental

The tunnel diode tester was modified in order to improve the balance condition of the bridge. A calibration circuit is still to be added.

In order to test the validity of the loss-less transmission line assumption, a 30-inch strip line was tested as shown in Figure 2.

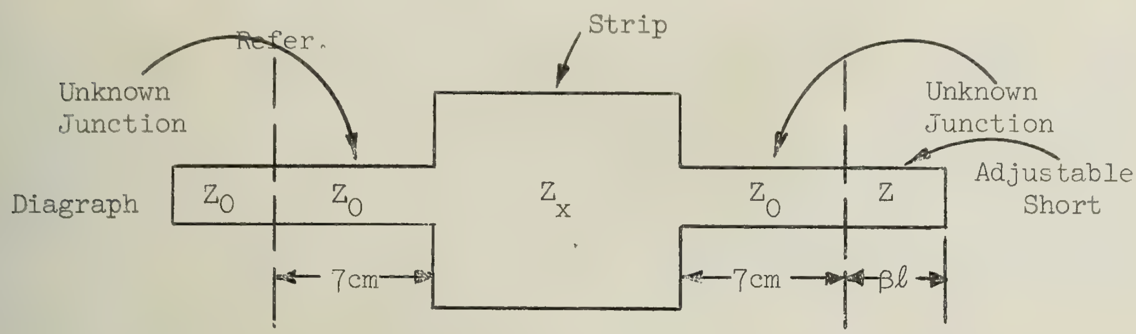

Figure 2. Test Set-up for Strip Lines

The length of βR was varied until the diagraph indicated a closed contour. The value of Z_x was taken as shown in Figure 3.

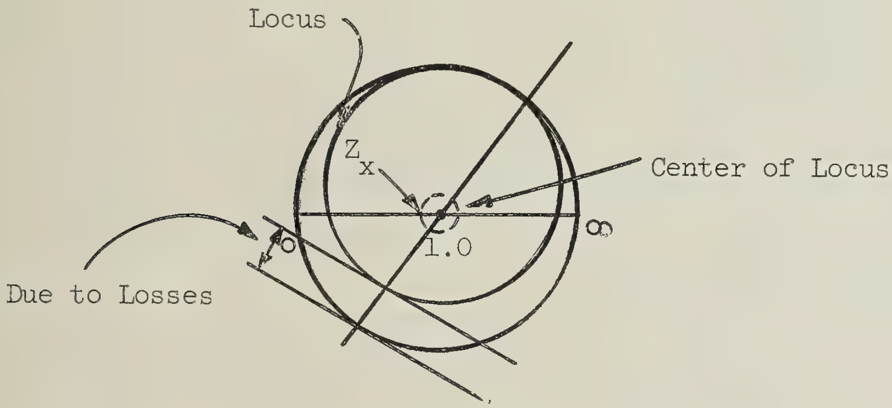

Figure 3. Determination of Z_x from Smith Chart

For the model studied the calculated impedance was 33 ohms, the measured 36 ohms for $300 < f < 1500$ mc. The losses were found to be small. A more accurate measurement will be performed on the coupled structure.

A jig has been designed to hold the coupled section, bias networks and measuring probes for the amplifier experiments. Suitable tunnel diodes are ordered.

3. Associative Memory Work

A preliminary design of a tunnel-diode associative memory has been considered. This sytem would be capable of locating any word stored in the memory. An experimental model of two words (two bit words) capacity will be constructed, hopefully verifying the theory and the calculations.

The organization of the system in shown on Figure 4, a storage cell with its connections is illustrated on Figure 5 and the bistable characteristic of a tunnel-diode series-resistor combination is shown in Figure 6.

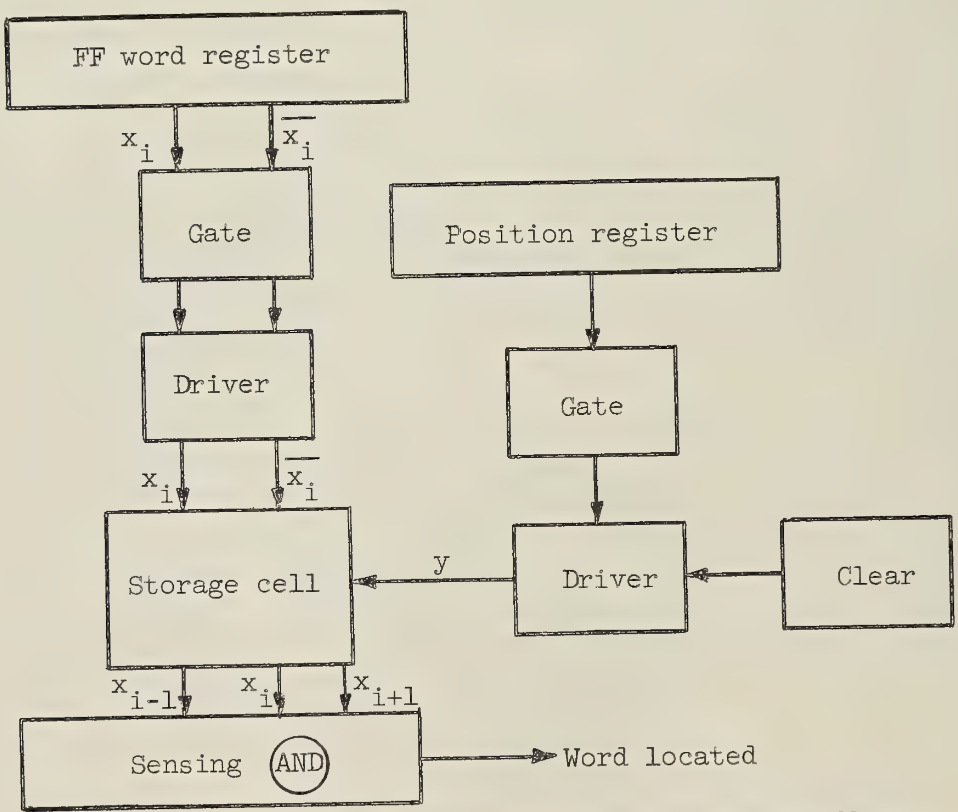

Figure 4. Block Diagram of the Associative Memory

There are two basic modes of operation:

1. Write a word into a given location in the memory.

2. Readout: locate a given word in the memory.

These operations occur as follows:

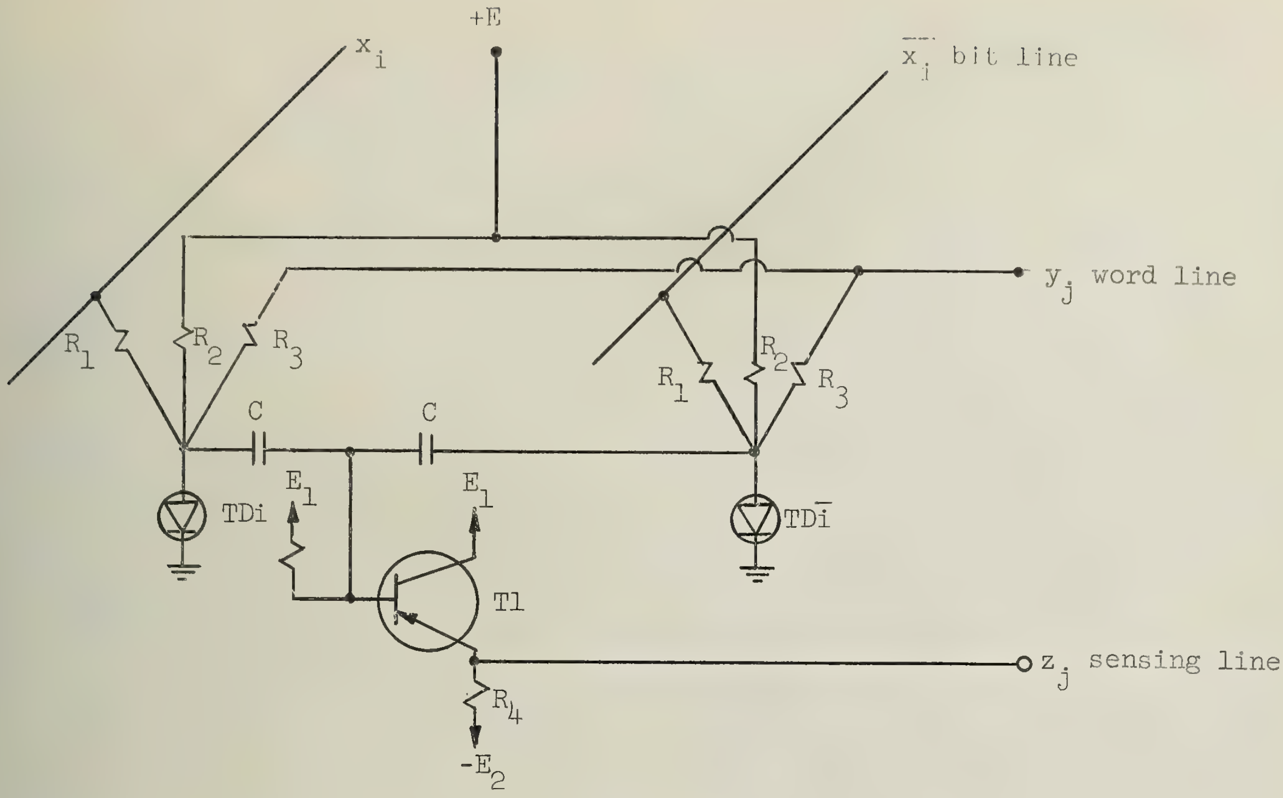

Figure 5. Storage Cell (one bit stored)

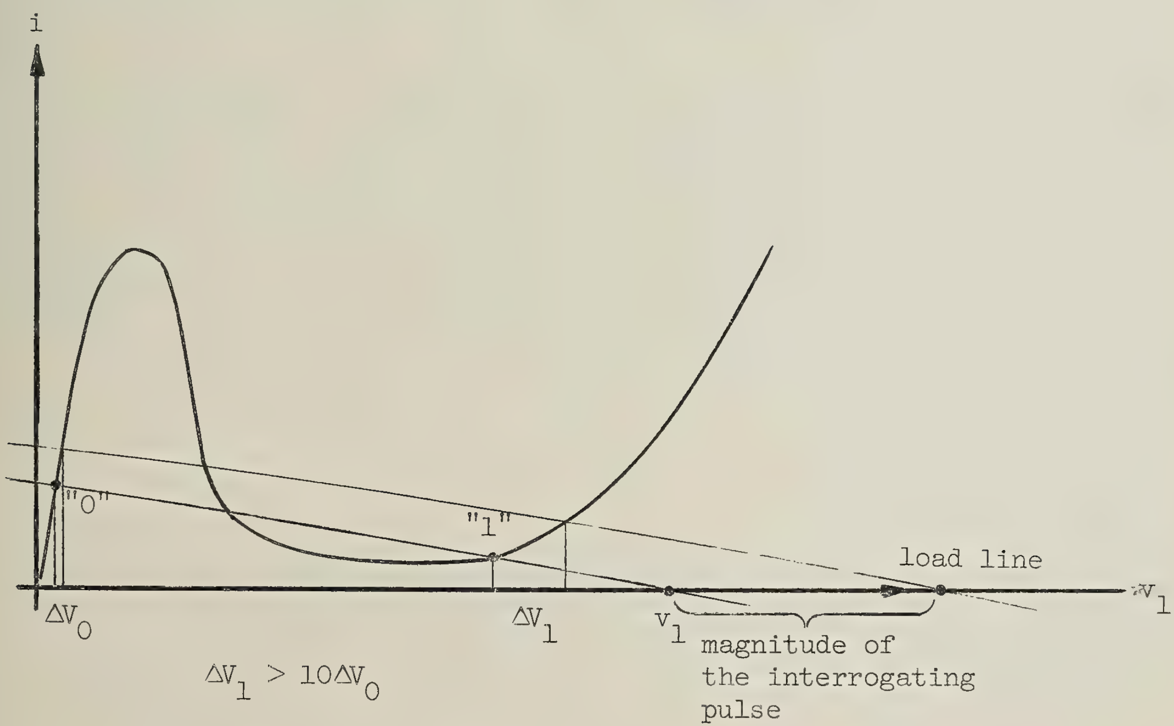

Figure 6. Sensing of Tunnel Diode State

1. The "write" consists of

   a. clearing all cells on the desired word line j to the low voltage "0" state; this is accomplished by sending a negative pulse on the y_j line.

   b. the cells are set to states indicated by the word register.

   The coincidence of x_i <u>and</u> y_j set TD_i to the high voltage state (x_i of y_j alone is not sufficient).

2. The "readout" cycle consists of

   a. "interrogating" pulses being gated on the X lines (corresponding to the bits of the word to be located). These (positive) pulses do not have sufficient magnitude to change TD states; however, a small voltage change on the TD occurs, the magnitude depending on the state of the tunnel diode.

ΔV_0, ΔV_1 are observed voltage changes across tunnel diode corresponding to the "0" and "1" states respectively.

The ΔV change is sensed by an emitter follower, which is connected to an AND circuit. If $\Delta V_i = \Delta V_1$ then the "stored" and the "searched for" words agree in the ith bit; if for some j all bits agree (i.e., $\Delta V_i = \Delta V_1$ for all i) then the word is found, indicated by a one output on the corresponding AND circuit. The numerical values of the components remain to be chosen, the resistor values being dependent on the available tunnel diodes.

The present design requires two tunnel diodes, and a transistor for bit stored and of course the associated driving, gating circuits, registers and power supplies.

4. Statistical Analyzer

Several possibilities were investigated for the high impedance discriminator circuit. So far, none have been satisfactory. This circuit looks at the voltage across the 1 K resistor of the diode circuit shown in Figure 7.

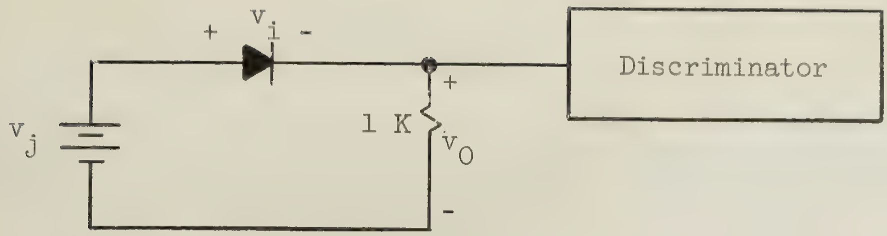

Figure 7. Discriminator Sampling Diode Circuit

There are to be nine discriminator circuits connected in parallel to the 1 K resistor (May, 1962, Progress Report). The input impedance of each circuit must be at least 100 K. Thus the input impedance of the nine together will be greater than 10 K which will disturb the voltage and current of the 1 K resistor by no more than ten per cent.

The output voltage range will be divided into channels which are .3 volts in width. A discriminator should switch from one state to the other in .03 volts so the voltage channel can be determined within ten per cent error. If the discriminator has an input impedance of 100 K, then it must switch when the input current changes by only

$$i_{in} = \frac{.03 \text{ volt}}{100 \text{ K}} = .3 \ \mu\text{a}$$

Furthermore, the voltages appear across the 1 K resistor as voltage pulses 1 μsec in width and it is the pulse height that is being looked at. The output of the discriminator is another square pulse, 1 μsec in duration, with a height of six volts if v_O is above the discriminating voltage and zero volts if v_O is below the discriminating voltage.

Investigation will continue to find a circuit to meet these restrictive requirements.

PART III

SWITCHING THEORY

(Supported in part by the Office of Naval Research under Contract Nonr-1834(27).)

During the last two months work has proceeded on the problem of extending the notion of regularity of sets of sequences, as defined by Kleene, to include infinite as well as finite sequences. This extension is fundamental to the setting up of a correspondence between asynchronous circuit theory and classical automata theory.

Three models of regularity have been established. These may be loosely described as (i) the sequential machine model, (ii) the linear graph model, and (iii) the regular expression model. All three of these models have been shown to give equivalent definitions of regularity when only finite sequences are involved. When infinite sequences were also included it was possible merely to show that (i) implies (ii) and (iii), and that (ii) and (iii) imply each other. Until recently, complete equivalence had not been proved, although it could be shown to depend upon the possibility of proving that the sequential machine definition of regularity is invariant under a direct homomorphism induced by a mapping from the input alphabet onto some other alphabet. Now this latter result has been obtained, although the proof is lengthy.

(David E. Muller)

PART IV

MATHEMATICS

Monte Carlo Methods in Quantum Statistics (Supported in part by the Office of Naval Research under Contract Nonr-1834(27).

Some preliminary calculations have been made with the program known as FJ-17 (see Technical Progress Report, December, 1962) which estimates the Wiener integral of the functional

$$F = e^{-\beta \int_0^1 V[r(t)]dt}$$

where V(r) is the potential function

$$V(r) = \alpha[(\frac{1}{r})^{12} - (\frac{1}{r})^{6}]$$

and the "Wiener path" r(t) is an interchange of a pair of particles . Some modifications are being made in this program.

We are continuing to study general numerical techniques for evaluating Wiener integrals.

(L. D. Fosdick, H. Jordan)

Mersenne Numbers

The sequence $M_p = 2^p - 1$ where p takes on successive prime values is called the Mersenne sequence, and yields primes for p = 2, 3, 5, 7, 11, 13, 17, 19, 31, 61, 89, 107, 127, 521, 1279, 2203, 2281, 3217, 4253, 4423. No other Mersenne primes exist with $p < 6000$. All factors of a composite Mersenne number are of the form $2qp + 1 = 8\ell \pm 1$. If no small factor is known, the Lucas test can be used to determine whether or not M_p is prime, without, however, giving any information about its divisors if it is composite.

Define

$$U_1 = 4$$

$$U_{i+1} \equiv U_i^2 - 2 \mod 2^p - 1$$

Then M_p is prime if and only if $U_{p-1} \equiv 0 \mod 2^p - 1$. The basic operation, the squaring of a multiple length number and reduction modulo $2^p - 1$, is suitable for ILLIAC II and can be checked modulo $2^{44} - 1$. The Lucas test was programmed and tried for all eligible $p < 6000$ and also for $p = 8191$, a test which took 100 hours on ILLIAC I, 5.2 hours on an IBM 7090 and 49 minutes on ILLIAC II. M_{8191} is composite and the last residue U_{8190} has the same value as D. J. Wheeler found on ILLIAC I. A search for Mersenne primes with $p > 6000$ is in progress.

(D. B. Gillies)

PART V

IBM 7090-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

NEW ROUTINES

F1-UOI-MAMI-26-S Floating Point Matrix Multiplication. This assembly language coded subroutine uses double-precision summation to compute the product of two real matrices. The factors and the product, however, are stored in the usual single-precision forms as two-dimensional floating-point FØRTRAN arrays. The purpose is to suppress the accumulation of round-off error which is otherwise incurred in summing rounded products to form a cell of the product matrix.

The routine has four entry-points, and by suitable choice of one of these the user may obtain with equal ease any one of the four products

$$AB, A^TB, AB^T, A^TB^T,$$

where the superscript T denotes transposition.

Originally programmed for IBM 704 by Phillip Deuel, Computer Center, University of California, Berkeley, California.

(D. W. Hutchinson)

LABEL	TITLE	ORIGINAL AUTHOR	REWRITTEN CHECKED, EDITED OR MODIFIED BY
B1-UOI-SIN1-9-S	Floating Point Sine-Cosine	G. A. Westlund MURA	D. Hutchinson
B1-UOI-SIN2-10-S	Fixed Point Sine and Cosine	E. M. Zographos MURA	D. Hutchinson
B1-UOI-ATN2-14-S	Fixed Point Arctangent	R. F. King MURA	D. Hutchinson
B2-UOI-LOG3-12-S	Fixed Point Logarithm, Base E	L. D. Fosdick MURA	D. Hutchinson
B3-UOI-EXP5-4-S	Floating Point Exponential	G. A. Westlund MURA	D. Hutchinson
B3-UOI-EXP4-5-S	Fixed Point Exponential, Base E	D. W. Hutchinson U. of ILL.	D. Hutchinson
B3-UOI-EXP6-6-S	Fixed Point Exponential, Base 2	L. D. Fosdick MURA	D. Hutchinson
B3-UOI-EXP7-7-S	Fixed Point Exponential, Base E	L. D. Fosdick MURA	D. Hutchinson
B3-UOI-LOG1-8-S	Floating Point Natural Logarithm	G. A. Westlund R. Christian MURA	D. Hutchinson
B3-UOI-LOG4-13-S	Fixed Point Logarithm, Base 2	Elizabeth Chapman R. F. King MURA	D. Hutchinson
B4-UOI-SQR2-3-S	Floating Point Square Root	D. W. Hutchinson U. of ILL.	D. Hutchinson
B4-UOI-CUR2-11-S	Floating Point Cube Root	M. R. Storm MURA	D. Hutchinson
B4-UOI-SQR1-22-S	Fixed Point Square Root	R. F. King M. R. Storm MURA	D. Hutchinson
B4-UOI-SQR3-24-S	Fixed Point Square Root	D. Hutchinson Sharon Wolfe U. of ILL.	D. Hutchinson Sharon Wolfe
C3-UOI-FAC1-16-S	Floating Point Factorial	G. A. Westlund MURA	D. Hutchinson
C3-UOI-CEI1-21-S	Complete Elliptic Integrals, Fixed Point	Elizabeth Chapman MURA	D. Hutchinson
D2-UOI-RKY1-17-S	Fixed Point Runge-Kutta	L. D. Fosdick MURA	D. Hutchinson
D2-UOI-RKY3-20-S	Floating Point Runge-Kutta	Elizabeth Chapman MURA	D. Hutchinson
F1-UOI-MAM1-26-S	Floating Point Matrix Multiplication	P. Deuel U. of CAL.	D. Hutchinson
J5-UOI-SCP3-15-S	General Alphanumeric Cathode Ray Display	L. D. Fosdick MURA	D. Hutchinson
J5-UOI-SCP1-23-S	General Axes and Point Plotter	D. Hutchinson U. of ILL.	D. Hutchinson

LABEL	TITLE	ORIGINAL AUTHOR	REWRITTEN CHECKED, EDITED OR MODIFIED BY
L1-UOI-SSA1-1-BX	SCAT	SHARE	M. Cross R. Flenner J. Snyder
L1-UOI-SCRE-19-BX	SCATRE	University of Michigan	W. Wulf
L2-UOI-MAD1-2-BX	MAD	University of Michigan	R. Flenner J. Flenner
M2-UOI-CNV1-18-S	Fixed Point Binary Fraction to BCD Conversion	D. Hutchinson	D. Hutchinson

1301 DISK FILE

Early in February, an IBM 1301 Disk File and associated 7631 File Control was connected via a 7909 Data Channel to Channel E of the 7090. This device provides for the storage of over 55,000,000 (six bit) characters with a sequential transfer rate to and from the 7302 core memory of 90,000 characters per second. Further information on the characteristics of and programming for this device can be obtained from the manuals:

A22-6528-3	Reference Manual IBM 7090 Data Processing System
D22-6576-1	General Information Manual 1301 Disk Storage with 7631 File Control
G22-6595-2	IBM 1301 Disk Storage

This disk is intended to be integrated into PORTHOS, the University of Illinois Operating System. Possible uses for the disk could include:

a) Storage for the operating system itself.
b) Buffer areas for system use during assembly, compilation, and input-output operations.
c) Storage of user programs with simplified production, code-check, and alteration runs as simple control card operations.
d) Computer logging and bookkeeping operations.
e) Simplified and more automated supervisory programs for class problems.
f) Back-up storage for users.

In addition, system routines will be provided for the user in order to simplify reading from and writing onto the disk file.

Until the disk is used in the above manner, users of the Laboratory's facilities can use it freely. However, since no systems routines to operate the disk as yet exist, those users will have to program their disk operations in machine language.

At this time it cannot be predicted how much of or which portion of the disk file will be used for system applications. Hence, any programs prepared to use the disk should be written so as to minimize the changes that will have to be made when part of the disk is made unavailable by the system uses and when system subroutines become required as the mode of using the disk.

At this time the disk is not run unless needed. Furthermore, certain disk operations (e.g. format recording) require manual operator intervention. Hence, any user of the disk should coordinate his runs with the machine operating staff.

SHUTTLE SERVICE

In order to further improve service and turn around time for short computer runs (in general research code checking), a new convenience was inaugurated on Monday, February 25, 1963.

The box for shuttle problems will be emptied three times each day at

9:00 A.M.
2:00 P.M.
9:00 P.M.

The material will be immediately loaded, run, printed, broken up and returned. It is hence expected that users submitting this type of work can establish a definite schedule since time of return will be definite.

To be included in this shuttle category a given run must satisfy <u>all</u> of the following conditions.

1) An <u>execution</u> time of less than 1 minute.
2) An <u>execution</u> printing of less than 200 lines.
3) An <u>execution</u> punching of less than 50 cards.
4) Have less than 500 assembly language cards.
5) Have less than 50 FORTRAN cards <u>or</u> less than 150 MAD cards.
6) Have less than 500 binary cards.
7) Have less than 100 data cards.
8) Be non-class work.

The Laboratory could well be forced to change these limits in either direction in order to maintain the short turn around time which is the object of this service. The entire success of this method depends on keeping the <u>total</u> running time of a given batch within bounds. Hence if the number of runs becomes excessive, the restrictions on each run must be increased.

Initial experience with this service has been excellent. The total turn around time has averaged one hour and forty-five minutes.

During the month of February, 51 problem specifications were submitted for the IBM 7090.

228-32001 Plant Pathology. Field Corn Disease Research. This research project involves testing of stalk rot and leaf blight in hybrids and inbreds. It also is concerned with developing lines, inbreds, and hybrids resistant to the above mentioned diseases. In this connection lines, inbreds and hybrids will be tested in replicated trials and analysis of variance will be used to test if there are differences. Plants will be rated as to their disease resistance.

229-32002 Chemistry. Stability Constants and Heats of Reaction. Several methods exist for the determination of the stability constant and subsequent heat of reaction for the formation of a complex, using spectrophotometric data. Error limits may be calculated for each determination when any of the specific methods is used. The present investigation is designed to eliminate several of the algebraic steps involved in these calculations, and to substitute a program consisting of two parts which can be used for rapid routine data processing.

The object is, then, the design of a two step program which calculates the stability constant for a one-to-one complex at several temperatures, followed by calculation of the heat of reaction for the complex formation. Error limits will be incorporated such that the total input will be in the form of spectrophotometric data as well as reactant concentrations, and output will consist of stability constant and heats of reaction with respective error limits.

230-32003T Geology. Limestone Classification. One hundred and seventy specimens of limestone were collected from seven geographical localities in Southwestern Indiana. All the samples were thin sectioned and then studied petrographically with a microscope. A description of the limestone types was made and expressed as values measured against twelve different selected variables.

It is proposed to treat these data by factor analysis using a varimax rotation. The data from localities 1, 2, and 3 are to be considered together as a group and the data obtained from localities 4, 5, 6, and 7 to be considered as a second group. It is instructive to compare geologically any differences in classification, resulting from the factor analysis of data from localities 1, 2 and 3; the factor analysis of data from localities 4, 5, 6 and 7; and the interpretation already made by intuitive reasoning.

231-32004 Chemistry. Calculation of Nuclear Magnetic Resonance Spectra. This research project is devoted to the calculation of chemical shifts and coupling constants from spectral frequencies and intensities in high resolution nuclear magnetic resonance. In the past, a programm designed for the Illiac computer has been employed. Now it is proposed to modify this and to use it with the IBM 7090.

232-32005 Civil Engineering. Error Research in Geodetic Direction. Essentially, this research is an investigation of the characteristics and propagation of both the random and the systematic errors involved in the determination of geodetic position and direction through observation of various celestial bodies.

Currently there are approximately one hundred eighty sets of observations for the determination of the azimuth of a line situated at the Vermilion River Observatory, and it is anticipated that at least one-thousand additional observations will be taken during the summer of 1963. The reduction of these observations on a desk calculator is tedious and time-consuming (the reduction of six observations requires more than two hours); thus, the use of a data processor becomes desirable, owing to the great reduction in computation time and to the elimination of the possibility of computational blunders.

In addition to the immediate benefits mentioned, general benefits will be obtained in the successful execution of a program or programs designed to process celestial data for directional control. It is conceivable that this facility may provide for greater latitude in the selection of observational modes which previously have been avoided because of excessive reduction time.

At the present it is difficult to ascertain all the possibilities which may be introduced by the use of the IBM 7090 in the processing of celestial data for directional determination, but it is certain that additional applications will arise other than the present application (reduction of azimuth observations).

233-32007T Psychology. Job Satisfaction Study. In an attempt to determine whether job satisfaction can be predicted by assessing the degree to which certain needs and expectations are fulfilled in a job situation, 70 subjects have provided "before and after" data related to their initial expectations and subsequent realization of 112 job characteristics.

These 112 items, along with the ten items used on two separate criterion measures, provide the variables for this analysis. For each of the job characteristics, there is data related to the importance of that variable for the job happiness of each individual and also a measure of the probability that he would find the same characteristic if he were employed full-time for Corporation X, a southern electronics manufacturer which hired the subjects for a summer training conference.

The present analysis is to determine whether the two measures--importance and probability--have the same or similar structures. The analysis requested is a series of factor analyses, first of importance over subjects, then of probability over subjects, and finally, of the ten items used on criterion measures.

234-32008 State Water Survey. Yield and Fill. The 7090 will be used to reduce data for a forthcoming State Water Survey Publication dealing with the potential water resources of Illinois. In the present program, the estimated yield and the volume of earth work required for each of 250 potential reservoir sites will be computed. Basic relations for the yield computation are:

Net Yield = Gross Yield - Evaporation,

Gross Yield = (Mean Flow) (% of flow for draft rate) (Duration of draft)

Evaporation = (Pool area) (0.65) (Experimental Evaporation)

The formula to be used in computing earth work is:

$$V = W \frac{T_W(H+C)}{2} - \frac{W \quad CT}{2} - 1/6\,(S_L + S_R)\,(T_W + 2T)\,H^2 + MT_D P_D + MT_u P_u$$

where, V = volume of earth fill in dam.

T_W = bottom width of dam

H = height of dam

C = distance from top of dam to intersection of side slopes.

T = top width of dam

$S_L = S_R$ = slope of abutments

T_D = thickness of downstream berm

P_D = depth of downstream berm

T_u = thickness of upstream berm

P_u = depth of upstream berm

M = mean length of berm

235-32009T Chemistry. High Speed Polymer Generator. This work is a part of the continuation of work on a previous high speed polymer generator. It is the generation of restricted self-intersecting polymers in two dimensional square lattice. A polymer is generated segment by segment on the computer and self-intersecting points are observed. The number of intersections is counted for a given polymer size. Polymers are grouped according to the number of intersections and the end to end distances are calculated as well. The generation procedure requires logical operations rather than arithmetic calculations.

236-32010 Digital Computer Laboratory. Time Comparison of Matrix Multiplication on the IBM 7090, IBM Stretch, and Illiac II. This problem involves the multiplication of two 100 x 100 matrices together to obtain a third matrix. The actual time of multiplication will be measured and used in comparison with the actual times required on the same problem run on the IBM Stretch and Illiac II.

237-32011T Physical Education for Women. Prediction of Endurance of Young Women. The problem is to predict the endurance of young college women on basis of various metabolic measures.

Since the data apparently do not show a definite rectilinear trend it seems necessary to find equations for curves which will represent the trend. Multiple regression will be used to solve the problem.

The number of subjects tested for this study was 93; the original number of variables for each subject was 47 of which approximately 17-20 will be used for prediction purposes.

238-32012 Psychology. Personality Factors in Delinquency. The study is designed to improve measurement of personality factors in delinquency.

A questionnaire consisting of 450 items which discriminate between delinquent and non-delinquent adolescents has been administered to about 1,000 subjects. 100 of the items have been used in previous research, and were chosen for this study because they display high loadings on 3 factors isolated in that research. A replicative factorization of these items is now proposed. If the factors which emerge are clearly congruent with those which have appeared before, loadings will be assigned the 350 new items through a series of Dwyer extensions. If the factors which emerge cannot be identified with those which have been isolated before, another strategy will be pursued (successive factorization of all 450 items in the questionnaire).

239-32013T Chemistry. Spectral Intensity Calculations. The temperature dependence of vibrionic visible absorption intensities in Vanadyl Acetylacetone and other first-row transition metal chelates will be investigated. Specifically, the following equation will be verified, by testing whether it can be fitted to experimental data from temperature-dependent spectra:

$$f_{kk'} = N \left\{ 1 + \sum_a \nu_a^{-1} \operatorname{ctnh} \frac{h\nu_a}{2kT} \left[\sum_{s \neq k} \left(\frac{\partial \lambda_{sk}}{\partial Q_a} \right)_o \frac{M_{sk'}(o)}{M_{kk'}(o)} + \sum_{s \neq k'} \left(\frac{\partial \lambda_{sk'}}{\partial Q_a} \right)_o \frac{M_{sk}(o)}{M_{kk'}(o)} \right]^2 \right\}$$

where $f_{kk'}$ is the theoretical oscillator strength for the $k \rightarrow k'$ electronic transition, N a numerical factor, ν_a the frequency of the normal mode Q_a, $\left(\frac{\partial \lambda_{sk}}{\partial Q_a}\right)_o$ the vibrionic perturbation energy per unit displacement in the normal coordinate Q_a, M_{sk} (o) the zero order transition moment for $s \rightarrow k$ in the absence of vibrionic perturbation, and where k, T, and h are the Boltzman factor, temperature and Planck's constant respectively.

As only one electron transitions are of interest, a determination of molecular orbitals by matrix (symmetric) diagonalization methods will be made. Furthermore for the computation of the

$$\left(\frac{\partial \lambda_{sk}}{\partial Q_a}\right)_o \text{'s}$$

a vibrational coordinate analysis of the molecular skeleton using the Wilson GF-Matrix method will be employed.

240-32014T Civil Engineering. Dynamic Response of Continuous Bridges. This problem is concerned with the development of a simplified method of analysis and design for a three-span continuous highway bridge subjected to moving loads. In the course of the investigation it is planned to accumulate and study both the analytical and the available experimental data on the subject.

In this study, the bridge will be idealized as a continuous beam, that is, vibrations in the transversal direction are disregarded. The mass of the beam will be considered as concentrated at certain points, whereas its flexibility will be assumed uniformly distributed along the beam.

The method of analysis will consist in dividing the beam into a given number of intervals, and at each interval integrating numerically the differential equations of motion that govern the vehicle and the bridge. Since this involves a large number of iterations, and it is necessary to consider a large number of intervals along the beam to insure convergence and stability of the solution, the IBM 7090 will be used to a great advantage in this problem. In addition to this, it is expected to have the computer scan within the realistic range of the parameters involved, for the combination of them that will produce the worst conditions of loading on each bridge. This will be of considerable value for the design of this type of bridge.

241-32016T Physics. Helium Photoproduction. The problem is that of performing a numerical integration in five dimensions, one of these being an essential integration of the impulse approximation theory of photopion production from helium and the other four being integrations over counter angles -- essentially a counter resolution problem.

When a photon of energy ν_o is incident on a He^4 nucleus, a pion of momentum π and a proton of momentum p are given off. The impulse approximation gives the cross section for this process as:

$$\sigma = \iint d\Omega_{\pi} \iint d\Omega_{p} \int dp \frac{\pi p\,(\mu^2 + m_p^2 + 2\pi_o p_o - 2\vec{\pi} \cdot \vec{p})}{(\mu^2 + \pi_o p_o - \vec{\pi} \cdot \vec{p})} \frac{\left(1 - \frac{\vec{k} \cdot \vec{\nu}}{k_o \nu}\right) \rho(k) \frac{d\sigma}{d\Omega}}{\left(1 + \frac{\pi_o}{3m_p}\right)\left(\frac{\vec{k} \cdot \vec{\pi}}{\pi^2}\right)}$$

where Ω_{π} is the pion counter solid angle; Ω_p is the proton counter solid angle; p is the proton momentum in the laboratory; π is the pion momentum in the laboratory; μ is the pion mass; m_p is the proton mass; π_o is the total pion energy in the laboratory; p_o is the total proton energy in the laboratory; k is the momentum of the struck neutron in the laboratory; k_o is the total energy of the struck neutron in the laboratory; ν is the momentum of the incoming photon in the laboratory; ν_o is the total energy of the incoming photon in the laboratory; $\rho(k)$ is the momentum distribution of the struck neutron in the He^4 nucleus; and $\frac{d\sigma}{d\Omega}$ is the cross section in the center of mass for photopion production from a free nucleon.

The problem is essentially one of expressing the "natural" variables in the integral in terms of the measured ones. The integrals will be performed with a five point Gaussian integration over p and a three point Gaussian integration over each of the four counter angles. After inspection of the functions, it might be necessary to go to different numbers of points.

242-32017 Civil Engineering. A Study of the Effect of Storage on Surface Run-off. The problem concerns the study of the relationship that exists between rainfall and run-off for drainage basins. Treating the basin as a system, which operates on the rainfall (i.e. input) to produce the run-off (i.e. output), an attempt is made to investigate whether the system is linear or non-linear and to determine the system function.

In the earlier part of the study, the IBM 7090 will be used to solve the basic differential equation involved which is I (rate of inflow) - Q (rate of outflow) = $\frac{dS}{dt}$ (rate of charge of storage). The difference between the total inflow and the total outflow, at any time gives the total change in storage in the basin at that time. For a number of storms, and corresponding run-off, the storage in the basin at different times will be calculated, using the computer.

This equation involves two unknowns Q and S. Since there is only one equation, the number of unknowns has to be reduced to one. So, the storage S will be expressed as a function of

$$Q, \frac{dQ}{dt}, \frac{d^2Q}{dt^2}, \ldots$$

and I as

$$S = K_1 Q + K_2 \frac{dQ}{dt} + K_3 \frac{d^2Q}{dt^2} + \ldots\ldots + C I.$$

For a known storm and run-off, S, Q, $\frac{dQ}{dt}$, . . and I are known. The values to be determined are K_1, K_2, and K_3, . . . and C. For a given storm and run-off, S, $\dot{Q}$, $\frac{dQ}{dt}$, $\frac{d^2Q}{dt^2}$, . . . and I can be found at various times and the following equations can be written.

$$S_1 = K_1 Q_1 + K_2 \left(\frac{dQ}{dt}\right)_{Q = Q_1} + K_3 \left(\frac{d^2Q}{dt^2}\right)_{Q = Q_1} + \ldots + CI_1$$

$$S_2 = K_1 Q_2 + K_2 \left(\frac{dQ}{dt}\right)_{Q = Q_2} + K_3 \left(\frac{d^2Q}{dt^2}\right)_{Q = Q_2} + \ldots + CI_2$$

$$\ldots \qquad \ldots$$

$$S_n = K_1 Q_n + K_2 \left(\frac{dQ}{dt}\right)_{Q = Q_n} + K_3 \left(\frac{d^2Q}{dt^2}\right)_{Q = Q_n} + \ldots + CI_n$$

The values of K_1 K_2 K_3 . . . and C are to be determined by the method of least squares, and this is to be repeated for a number of storms.

243-32018T Agricultural Economics. Egg Production Contracts. Conditions are sought under which farmers will accept egg production and marketing contracts. Given the farmer's resources, possible alternative enterprises, input-output coefficients, price of each product, and the objective of profit maximization, a unique farm plan may be found which is better than any alternative. Optimum farm plans are to be found in which contract egg production will appear among the alternative enterprises.

Linear programming is a mathematical tool which can be used for finding optimum solutions of this kind. Problems expressed in a linear programming model can be solved on the IBM 7090 by use of the programming system LP/90.

244-32019 Agricultural Economics. Farm Machinery Costs. The total research problem is concerned with determining "when to replace farm machinery." At this time only farm tractors are being investigated although other machines will be included at a later date. The IBM 7090 is to be used to obtain some regression estimates for repair costs and resale prices. As many as six variables will be included. Repair costs are obtained from cross sectional data and resale prices from time series data. The computational procedure of multiple linear regression is to be used.

245-32021 Civil Engineering. Behavior of Reinforced and Prestressed Concrete Beams. The problem involves development of moment-curvature diagrams for reinforced and prestressed concrete beams. Only sections subjected to pure flexure are considered. The principal variables are, the stress-strain diagram for steel, that for concrete and the amount of reinforcement. The objective of the work is to determine analytically the effect of concrete strength upon the ductility and behavior of a reinforced or prestressed concrete beam. The results thus obtained will be compared with those obtained from experimental work.

246-32029 Digital Computer Laboratory. Preliminary Checking of Scanning - Measuring Projector Programs. A bubble chamber data analysis system is soon to be put into operation based upon the scanning-measuring projector currently being built at the Lawrence Radiation Laboratory

University of California, Berkeley, California. Prior to the arrival of this equipment, it is necessary to make preliminary checking runs on the various analysis routines so that these will be in readiness for the arrival of the equipment. The routines to be checked consist of tracking routines, spatial reconstruction routines, least square fitting routines and kinematic analysis.

247-32030 Chemistry. Fourth Field Gradient Integrals. An attempt is being made to explain certain anomalies in the rotation-vibration spectrum of HCl molecules isolated in an argon lattice near $0^{o}K$. Briefly, the theory explains the observed perturbations as being due to the interactions of the induced hexadecapole moment of the HCl molecule with the fourth gradient of the electric field due to the argon atoms, at the center of mass of the HCl molecule. The field gradient and hexadecapole moment are calculated from known wave functions for HCl and argon, and the computer will be used to perform the many numerical integrations necessary in evaluation of these quantities.

248-32031 Chemistry. Tubular Chemical Reactors. Consideration is given to selected topics in tubular chemical reactor analysis including: some optimal design problems in distributed parameter models, critical evaluation of some commonly employed mathematical models, chemical reaction in laminar annular flow and in coil reactors. The transport equations in all cases will be solved numerically on the IBM 7090 computer, and techniques of dynamic programming will be employed in some of the optimization problems.

249-32020 Chemistry. Molecular Structure Determination. Through the use of microwave spectroscopy, structure determinations of the cis-dichloroethylene and methylene cyclobutane molecules will be attempted. To do this, it is necessary to assign the rotational spectra of each compound with different isotopes substituted at various positions in the molecules.

The rotational energy levels are determined by matrix methods. The rotational matrix techniques have been partially developed earlier. These methods will be extended to determine the structure of the above two molecules. This will involve the diagonalization of several large matrices.

250-32023T Education. Partial Correlations I. This problem uses a recursive formula for deriving partial correlations among data from an urban school system. The data include achievement and routine central office pupil accounting data.

251-32022 Physics. Interaction of Fast Dislocations. The problem consists of anticipating the ability of a fast moving dislocation to overcome dislocation interactions and then applying the results to the growth of deformation twins.

The movement of the interacting dislocations is described by a very non-linear differential equation. This equation has been solved in series to terms in t^7. The IBM 7090 will be used to compute the algebraically complicated coefficients in this expansion in terms of the input condition.

A similar procedure will be used for the application to the problem of deformation twinning.

252-32034 Electrical Engineering. Magnetic Dipole Antenna Calculation. The problem is to calculate the far-fields generated by current flowing on circular loops. This will involve the superposition of the fields generated by several circular loop antennas, each with given parameters. The fields involve the calculation of Angers functions of various arguments, depending on the azimuthal angle. Angers functions are given by

$$2J'_{\nu}(-z) = \frac{2\,\mathrm{Sin}\,\nu\pi}{\pi}\left[\frac{1}{\nu}\sum_{n=1}^{\infty}\left\{\frac{(-1)^{n+1}\,2nz^{2n-1}}{\prod_{k=1}^{n}\left[(2k)^2-\nu^2\right]}\right\}\right.$$

$$\left.+\sum_{n=1}^{\infty}\left\{\frac{(-1)^{n+1}\,(2n-1)\,z^{2n-2}}{\prod_{k=1}^{n}\left[(2k-1)^2-\nu^2\right]}\right\}\right]$$

It is desired to truncate this infinite series such that 4 decimals of accuracy are attained. There will be 360 values of z for each loop, and perhaps 4-6 loops tested per run.

253-32025 Dairy Science. Cross Breeding Modified Least Squares and Regression Analysis. The problem concerns obtaining least squares estimates of constants for all degrees of freedom available among subclasses in each specified analysis for the various traits concerned. The estimates of the constants are obtained by B = KM, where B is the column vector of constants, K is the matrix of coefficients for the orthogonal comparisons, and M is the column vector of subclass means. The error sum of squares which is the sum of squares within subclasses will also be computed. $C^{-1} = KD^{-1} K^{1}$, where C^{-1} is the matrix inverse of the complete variance-covariance matrix, K' is the transpose of K above, and D^{-1} is the inverse of the diagonal matrix of subclass number. The C^{-1} matrix is used to compute the standard errors of constant estimates and comparisons, as well as the sums of squares of the various effects in an analysis of variance. The latter two operations, using C^{-1}, will not be performed on the 7090. Finally the sums of squares and sums of cross products within subclasses for the specific traits required in the partial regression analyses are obtained. This allows setting up the desired variance-covariance matrices and computing their inverses.

254-32034 Physics. Pi Plus Photoproduction. The problem is the evaluation of a long algebraic expression for the cross section for the reaction of positive pion photoproduction from hydrogen, according to the latest theoretical results. The evaluation is to be carried out for a number of values of various parameters, including photon energy, pion angle, pion-nucleous phase shift formulas, and multipion resonance coupling constants. Only common functions presently available in the 7090 are needed, such as square root, logarithm, arctangent, sine, and cosine.

255-32051T Institute of Communications Research. A Multidimensional Approach to Social Perception. The present research is to be classified within the area of social perception. The principal interest of this research is the establishment of certain "facts" about the way in which individuals perceive others in their social field. As such, this investigation will delve into the nature of the dimensions used by individuals in the perception of social objects.

Basically, the problem involves the comparison, by means of a multiple correlation procedure, of a space established by means of a multidimensional scaling technique to a space derived through the use of factor analysis.

For the most part, standard routines such as correlation, principal axis, and matrix multiplication will be used.

256-32050 Marketing. Factor Analysis of Consumption Expenditures. This computation is concerned with the testing of the hypothesis: A functional relationship exists among household characteristics and consumption expenditures. This testing requires a multivariable analysis in which a simple correlation matrix is constructed from numerical values assigned to the data, the extraction and rotation from this matrix by factor analysis follows. From the analyses of these factors it is hoped that some patterns of behavior can be observed and interpreted which will support the hypothesis heretofore stated.

257-32047 Agricultural Economics. Decision Simulation. Programs will be written and executed on the 7090 which will simulate the problem solving process of an economic decision maker. The programs will be non-mathematical in their operations and will employ hierarchial list structures of rules used in problem solving. A choice is to be made from alternative problem solutions. Output from the 7090 will consist of a trace which defines the process used by the computer in the solution of the problem. The computer language to be used will be IPL-V.

258-32046 Psychology. Criteria of Success. The solution of many problems connected with industrial executives (executive selection, executive training, promotion policies, etc.) requires an understanding of the dimensions along which success may vary. Past research on these problems has been relatively unsuccessful. This lack of success may be due to the somewhat inappropriate measures of success which have been used in the past.

The present study will be devoted to an analysis of the intercorrelations of 17 objective criteria of executive success obtained from a sample of 50 executives working for a large industrial concern in Chicago.

These indices of success were based on salary and position in the hierarchy corrected for tenure, age, starting salary, and starting level. A principal components analysis and a varimax rotation of the components will be performed on the intercorrelation matrix. A second step will be the determination of the relationship of the various success factors to subjective ratings of success. The final step will involve the relationship of various predictor variables to the dimensions of success isolated in the factor analysis.

259-32042 Physics. Pi Network Components. The problem is to produce values for circuit components to be used in the design of amateur radio transmitters. The program will build a table of values for widely varying circuit parameters; from those in transistorized equipment of the "handie-talkie" class up to transmitters of full legal power input.

260-32041 Electrical Engineering. Gyrofrequency Study. The nature of the problem is concerned with wave propagation in the upper ionisphere. Mathematical relationships used in this problem are not complex but repeated use of them is quite time consuming. No other routines other than those found in the standard library will be used.

261-32040 Mining, Metallurgy and Petroleum Engineering. Specialized Seismic Research. This problem involves the minimization of a certain quadratic form (eigenvalue and eigenvectors of a matrix). The coefficients of the latter are built up from large masses of seismological data.

262-32037 Industrial Engineering. Variance in Errors of Physical Measurement. When measurements are made of a physical quantity, the measurement observed consists of two quantities, a true or absolute physical measurement (x) and a term (e) which is the random variation due to the instrument being used and/or the individual making the measurement. If only one instrument is used an estimate of the (e) cannot be made. However, by using two instruments to measure x, a means exists to make an estimate of the variation of e.

Letting x_i be the absolute value of the physical entity and e_{ij} be the error due to the j th instrument, the following exists for

a group of measurements taken on n items by instruments I_1 and I_2

I_1	I_2
$x_1 + e_{11}$	$x_1 + e_{12}$
$x_2 + e_{21}$	$x_2 + e_{22}$
$\vdots$	$\vdots$
$x_n + e_{n1}$	$x_n + e_{n2}$

where $x_i + e_{ij} = O_{ij}$. O_{ij} are the actual observed values. The following formula is an estimate of the variance of instrument 1:

$$\text{est }(\sigma^2_{e1}) = \frac{\Sigma\,(O_{i1})^2 + \Sigma\,(O_{i1}O_{i2})}{n-1} - \frac{\left[\Sigma O_{i1}\right]^2 + \left[\Sigma O_{i1}\,\Sigma O_{i2}\right]}{n\,(n-1)}$$

where the summations are from $1 \rightarrow n$. A similar expression exists for est (σ^2_{e2}).

The normal random number generator in the 7090 library will be used to generate known variations which will be compared with the calculated estimates.

263-32036T Electrical Engineering. Antenna in Plasma. This program is written to calculate the input impedance of a short dipole parallel to a magnetic field in a plasma. The expression for impedance is straight forward, involving simple complex-number expressions. The expression is broken into real and imaginary parts. Calculations are done for neon at three specified pressures, and helium at one pressure.

264-32035T Chemistry. Electron Scattering Studies. This program uses the experimental data collected at a group of seven points to evaluate the coefficients in a power series of sixth degree. This is done for all the data in groups of seven. From this the derivative curve of the experimental data is obtained.

265-32033 Civil Engineering. Train Performance Simulator. The purpose of this project is to simulate the operation of a railroad train along a given route, taking into consideration the number and power of locomotives, number and weight of cars, and the grades, curvature, speed restrictions, and station stops along the route. The program output will consist of the potential time required for the train to reach specified stations

while performing its assigned duties.

The force available to accelerate the train (F_a) is the difference between the tractive effort supplied by the locomotives (T_e) and the resistance of the train (R_{train}):

$$F_a = T_e - R_{train}$$

The tractive effort at any given speed is determined by the relationship

$$T_e = 308 \times HP/V$$

where HP is the locomotives horsepower and V is the train speed modified to include grade and curve resistance.

$$R = Wn \left[1.3 + \frac{29}{W} + bV + \frac{CAV^2}{Wn} + 20g + 0.8C \right]$$

where

W = weight per car axle (tons)

n = Number of axles per car

V = Speed of train (MPH)

C = Coefficient of air resistance

A = Cross sectional area of car

g = Percent of grade

C = Degree of curvature

The total train resistance is the summation of the resistances of the locomotives and the cars.

The distance travelled while accelerating from one velocity to another is given by:

$$L = \frac{70x\ Wx\ (V_2^2 - V_1^2)}{F_a}$$

where W is the total weight of the train (tons) and V_1 and V_2 are in miles per hour. The time required for this acceleration is:

$$t = \frac{95.6 \times Wx\ (V_2 - V_1)}{F_a}$$

The input data for the program can be divided into two sets. One set contains the physical characteristics of the line; curves, grades, speed limits, etc. The second contains information about the train; locomotives, cars, resistance coefficients, etc.

Working on the basis of a constant time interval between successive calculations the computer will be used to determine the tractive effort, the accelerative force, the change in velocity, and the total distance travelled and time consumed as the train moves along the lines.

266-32032 Psychology. Relationships Between Overt and Fantasy Aggression. This research represents the first phase of a research program investigating the relationship between aggression expressed overtly and in fantasy. Last semester a variety of personality interview measures were collected from 40 subjects, involving characteristic styles of aggressive response. The same subjects have been asked to sort aggressive pictures according to their degree of aggressiveness, disturbingness, humorousness, and justice. It is desired to relate the subject's reactions to the pictures, as measured by his sorting behavior to his personality characteristics, as measured by his responses to the personality inventory. This study is a pretest for a larger study to be conducted this semester.

Additional personality inventory data on 200 subjects will be collected this semester. The same subjects will be asked to rate a sample of the stimulus pictures used in the sorting study, and to tell stories to a smaller sample of the same pictures. The ratings and stories of the subjects will be analyzed and related to their personality characteristics, as measured by this personality inventory.

267-32053 Physics. Transition Rates in K^--mesic Atoms. The object of this calculation is an attempt to explain the experimental results obtained from observing the K^- meson captures "at rest" in nuclear emulsion. There are indications that the observed effects are almost completely dependent on the various atomic processes taking place from highly excited mesic states of the emulsion atoms. To verify this one computes the rates for transitions from mesic states $x_{n,l}$ to $x_{n',l'}$ for radiative (dipole, quadrupole . .), Auger and Stark processes. For each process the angular integration in the corresponding matrix element may be performed analytically. However, the radial part of the matrix element, in general, reduces to

$$M(n,l,n', l'; \lambda) = \int_0^{\infty} R_{nl}(r)\, r^{\lambda}\, R_{n'l'}(r)\, dr \qquad \lambda \geqq 3$$

R_{nl} is the radial mesic wave function of the state $x_{n,1}$. In order to preserve accuracy in the computation of M for "large" n, a recursion formula in l must be employed, using as starting values, the values of M for l = n-1, n-2,... The complexity of the determination increases rapidly with λ.

268-32056 Ceramic Engineering. Glass Composition, Elasticity Corellation. The purpose of this program is to test the validity of a function relating the chemical composition of glass to the Young's modulus of elasticity of the glass. The function has been tested using a desk calculator and employing a small segment of data and shows considerable promise as a correlating device. It is intended to employ the computer to further test the function on a much larger body of data. Mathematically, the modulus of elasticity of a glass is expected to show a reasonable relationship to the void volume of the particular glass per number of gm-anions in the glass volume considered.

269-32057 Psychology. Adjustment. This study focuses on several criteria of individual adjustment in a military setting as dependent variables. Membership in experimental conditions or in military units having certain characteristics is the independent variable distinction.

Computer facilities will be needed primarily for variable intercorrelations and subsequent factor analysis and comparison of experimental conditions using analysis of variance.

270-32055 Office of Instructional Research. Prediction Tables. A large amount of student data will be collected in card form. This data will include such things as SCAT, math placement, and ACT scores, high school rank, sex, status, and college grades. From this data, a student data file will be created on the 7090. As more information is collected, the file will be updated. Multiple regression weights and correlations will be computed for the variables on tape and these, in turn, will be used to generate prediction tables on student success in both mathematics and English. These prediction tables will be stored on magnetic tape so that a comparison can be made at the end of the semester when final grades are received.

271-32058T Theoretical and Applied Mechanics. Shallow Shell Analysis. The problem to be investigated is the study of shallow hyperbolic paraboloid shells subjected to concentrated loads. The IBM 7090 will be used to evaluate a double sine Fourier series of the type

$$\sum_{m=1}^{\infty} \sum_{n=1}^{\infty} A_{mn} \sin \frac{m\pi X}{l} \sin \frac{n\pi Y}{k}$$

where the A_{mn} are known quantities. It is anticipated that summing m and n from 1 to 10 should give a good approximation to the equation.

272-32059T Theoretical and Applied Mechanics. Cyclic Creep. The research problem is experimental in nature. Data is to be taken on the mechanical behavior of metals acted upon by a constant axial stress and a cyclic torsional strain.

The computer is to be used to transpose load versus deflection data into stress versus strain data. No mathematical routines other than standard library routines are used. The remainder of the calculations consist of simple arithmetic only.

273-32060 Education. School Placement and Approach to Learning. This problem constitutes an investigation of how mentally handicapped children who have experienced differential school placement approach a learning situation. Mental age and chonological age variables are controlled by the inclusion of appropriate groups of children with normal intelligence. Analysis of covariance technique is to be used to control chronological age among groups 1, 2 and 3 and mental age among groups 1, 2 and 4. Thus groups 1, 2 and 3 are to be analyzed by covariance holding chronological age constant on a task base rate, on each cumulative minute and on the sum total of minutes two through five. Likewise, groups 1, 2 and 4 will be so analyzed with mental age held constant. In addition, each group will be analyzed by analysis of variance within the group and intercorrelations between the various measures related to their performance on the task.

274-32061T Theoretical and Applied Mechanics. Rotational Flow Towards A Step. A study of a turbulent boundary layer flow approaching a normal step is being made. The concept of a vorticity preserving flow (constant vorticity along a streamline) is used to describe the flow adjacent to the boundary layer and to define the separation regions in front of and on top of the step.

This method requires the solution of Poisson's equation,

$$\Delta^2 \psi = -\rho = -f(\psi),$$

where ψ is the stream function and ρ is the vorticity. The method of successive approximation is used in the solution and is applied to the values of the function ψ corresponding to the points on a mesh. The field is rectangular in shape except for the side that contains the step. Instead of the ordinary five point relaxation formula, a formula involving 16 points is used to assure rapid convergence.

275-32062 Natural History Survey. Correlation of Weather and Corn Stalk Rots and Ear Rots. The method of least squares is to be used to determine the relationship between the weather and rotting of corn stalks and corn ears.

276-32063 Mechanical Engineering. Two Dimensional Asymmetric Jet. In the study of the directional control of rocket thrust by fluid jets, a basic need is the establishment of asymmetric configurations of the fluid jets.

It is the intention of this problem to set up a program for the IBM 7090 to calculate such configurations by the method of characteristics for two-dimensional supersonic flows. The laborious, iterative, step-by-step procedure of calculation of the flow field may easily be handled by high speed machines.

277-32065 Psychology. Iterated Image-Correlations. This investigation will be concerned with the properties of iterated image-correlation matrices and their relations to factor analysis in general and the communality problem specifically.

278-32064 Mechanical Engineering. Calculation of Nozzle Contours. This calculation of nozzles for low density-hyper-velocity flows requires a step by step integration on the displacement thickness for connecting the straight methods of characteristics solution. It is intended to combine the straight method of characteristics solution (also tedious) with the displacement thickness connection in one program which will compute the entire connected nozzle contour for any designed exit machine number and stagination condition. This program should yield highly accurate solutions while saving extensive time even over such time saving (but less accurate) methods as graphical solutions.

During the month of February, four problem specifications were submitted covering class use.

I48-32015 Mechanical Engineering 260. Problem 1. Air Flow at an Inlet. A planar, uniform sink will be reproduced by several point sinks in order to calculate the velocity components at a grid of points various distances removed from the sink.

I49-32026 Chemistry 490. Problem 1. Solution of A Transcedental Equation. Write a program to read a number Y from a card with format E15.10 and print Y and X, where X is the solution of the equation:

$$Y = X^2 + e^X + \sin x/2$$

Use the iteration method discussed in class. Assume $1 \le Y \le 100$, and find $X \geq 0$.

I50-32049 Civil Engineering 391. Problem 1. Simple Beam Program. Using SCAT, the principles of logical decision making, address modification, and input-output will be illustrated. A simple example of the computation of shear forces in a beam is the actual physical problem chosen to demonstrate these computing principles. Only elementary algebra is required in the computation.

I51-32045 Mathematics 195. Problem 1. Polynomial Generation. Write a program to calculate

$$Z = (ax^2 + bx + c)^3$$

for x = 0 (1) 10

and a = -5

b = 7

c = 13

in fixed point arithmetic

Print results in five columns in the following order a, b, c, x, z.

Information on the utilization and reliability of the IBM 1401 and IBM 7090 for the month of February, 1963 is given in the tables below.

TABLE I - IBM 1401

Summary of Use

February, 1963

Scheduled Engineering	:15
Unscheduled Engineering	15:33
Air Conditioning	11:25
7090 Preparation	259:54
Tape Labeling	:54
Deck Reproduction	1:09
Listing	9:22
Code Checking	14:38
CDC Preparation	:59
Idle	8:05
Wasted	:35
	322:49

TABLE II - IBM 1401

Summary of Machine Errors

February, 1963

Air Conditioning	2
1403 Printer	4
729V Tape Units	2
1402 Punch	1
1402 Reader	2
TOTAL	11

TABLE III

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR-CONDI-TIONING	IDLE	WASTED	TOTAL TIME	FAILURES	IBM 1401 DAILY TIME DISTRIBUTION
2/1/63	8:30			7:15	:15		16:00	1	(1)Tape unit B failed to come out of a high speed rewind properly. (Air Conditioning system was scheduled for a new motor to be added to the outside fan system.)
2/4/63	15:55				:05		16:00		
2/5/63	15:41				:15		15:56		
2/6/63	15:05				:55		16:00		
2/7/63	15:27		:15		:20		16:02		
2/8/63	14:52				1:15		16:07		
2/11/63	14:53				1:15		16:08		
2/12/63	15:53				:10		16:03		
2/13/63	15:35					:35	16:10		
2/14/63	14:25		1:20		:15		16:00	1	(1)1403 printer randomly failed to print at position No. 38. Worn residual on hammer.
2/15/63	15:17		1:05		:10		16:32	2	(1)Card jam in 1402 punch. Punch die was not secure. (2)Tape unit (A) broke a magnetic tape.
2/18/63	14:52		1:03		:05		16:00	1	(1)Card reader would not read cards. Engineer cleaned read brushes.
2/19/63	15:24				1:15		16:39		
2/20/63	13:24		2:15		:20		15:59	1	(1)1403 carriage ran away. E_2 timer was off.
2/21/63	16:07				:20		16:27		
2/22/63	15:16	:15	:15		:30		16:16	2	(1)Tape unit (A) failed to drop head. Faulty relay switch. (2)1402 read stacker No. 2 would not report full. Pocket stop bail out of adjustment.
2/25/63	11:30			4:10	:20		16:00	1	(1)Gas leak from cooling unit causing failure of air conditioning.
2/26/63	15:50				:10		16:00		
2/27/63	6:40		9:10		:10		16:00	1	(1)Carriage on 1403 printer ran away. Valve broken in 1403 printer.
2/28/63	16:20		:10				16:30	1	(1)Carriage on 1403 printer ran away. Trouble caused by torn carriage tape.
	286:56	:15	15:33	11:25	8:05	:35	322:49	11	

TABLE I - IBM 7090

SUMMARY OF USE

FEBRUARY, 1963

Scheduled Engineering	67:44
Unscheduled Engineering	6:21
Air Conditioning	12:32
System Up-Dating	3:20
Production (see Table IV)	151:26
Idle	127:15
TOTAL	367:32

TABLE II - IBM 7090

SUMMARY OF MACHINE ERRORS

FEBRUARY, 1963

Air Conditioning	2
729 VI Tape Units	3
716 Printer Clock	2
Power Supply	1
TOTAL ERRORS	8

TABLE IV - IBM 7090

USE BY DEPARTMENTS - FEBRUARY, 1963

Department	Number of Runs			Total Number of Runs	Number of Problem Specifications			Total Number of Prob. Spec.	Time Used			Total Running Time
	Class	Research	Non system		Class	Research	Non system		Class	Research	Non system	
Agricultural Engineering		24		24		1		1		:32		:32
Agricultural Economics		16	5	21		4	2	6		:09	1:33	1:42
Agricultural Education		2		2		1		1		:03		:03
Agronomy		73		73		9		9		2:03		2:03
Animal Science		4		4		1		1		:01		:01
Civil Engineering		608		608		27		27		25:51		25:51
Ceramic Engineering		1		1		1		1		:01		:01
Chemistry	64	692		756	1	27		28	:25	19:34		19:59
Digital Computer Laboratory	19	458	31	508	1	12	3	16	:15	20:09	19:35	39:59
Economics		34		34		1		1		1:35		1:35
Education		30		30		3		3		:58		:58
Electrical Engineering	49	219		268	4	15		19	:52	4:07		4:59
Geology		2		2		1		1		:06		:06
Institute of Communications Research		15		15		1		1		:16		:16
Industrial Engineering	23	110		133	2	2		4	:25	3:34		3:59
Instructional TV		97		97		3		3		2:33		2:33
Mathematics		20		20		1		1		1:02		1:02
Mechanical Engineering	4	329		333	1	14		15	:02	6:44		6:46
Mining, Metallurgy and Petroleum Engineering		46		46		4		4		:35		:35
Men's Residence Hall Association Rocket Club		25		25		1		1		:31		:31
Music		23		23		1		1		:43		:43
Nuclear Engineering		10		10		1		1		:17		:17
Office of Instructional Research		4		4		1		1		:03		:03
Physics	41	601		642	1	22		23	:50	16:59		17:49
Plant Pathology		11		11		1		1		:03		:03
Psychology		155		155		10		10		3:53		3:53
State Geological Survey		13		13		1		1		:25		:25
Small Homes Council, Bureau of Residential Construction		10		10		1		1		:06		:06
Sociology		6		6		1		1		:07		:07

Department	Number of Runs			Total Number of Runs	Number of Problem Specifications			Total Number of Prob. Spec.	Time Used			Total Running Time
	Class	Research	Non system		Class	Research	Non system		Class	Research	Non system	
Statistical Services Unit		182		182		2		2		9:46		9:46
State Water Survey		134		134		5		5		2:15		2:15
Theoretical and Applied Mechanics	32	62		94	1	5		6	:25	1:41		2:06
Sub Total	232	4016	36	4284	11	180	5	196	3:14	126:42	21:08	151:04
Instruction		37	1	38						:06	:16	:22
Grand Total	232	4053	37	4322	11	180	5	196	3:14	126:48	21:24	151:26

TABLE III - IBM 7090

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR-CONDI-TIONING	IDLE	TOTAL TIME	ERRORS	IBM - 7090 DAILY TIME DISTRIBUTION
2/1/63	4:02			7:15	4:30	15:47	1	(1) Air Conditioning turned off for installation of outside fan motor.
2/4/63	7:51				7:56	15:47		
2/5/63	9:49	2:00			4:11	16:00	2	(1) Blown fuse in tape unit (T). (2) Tape unit (T) was taken off line. Relay No. 7 was found to be stuck.
2/6/63	8:29	1:00	1:24		5:06	15:59		
2/7/63	11:07	:15			4:43	16:05	1	(1) Multiple write skew errors on tape unit (Y).
2/8/63	7:24	2:00			6:36	16:00		]
2/9/63		24:00				24:00		] Installation of Disk File
2/10/63		24:00				24:00		]
2/11/63	7:17	3:07			5:23	15:47		
2/12/63	8:35	:20	1:45		5:20	16:00		
2/13/63	8:31	1:05			6:33	16:09		
2/14/63	8:38	1:00			6:27	16:05		
2/15/63	6:52	:35	1:30		7:18	16:15	1	(1) 716 Printer Clock fails to keep correct time. Burned point in relay found.
2/18/63	7:10	:35			8:10	15:55		
2/19/63	7:31	2:00	1:40		4:52	16:03	1	(1) Failed to get power up. Relay in power supply was found to be stuck.
2/20/63	5:05	1:05			9:50	16:00		
2/21/63	9:19	1:00			5:55	16:14		
2/22/63	8:22	:50	:02		6:46	16:00	1	(1) 716 printer clock fails to keep correct time. Burned point in relay found.
2/25/63	6:51	:55		5:17	2:52	15:55	1	(1) Gas leak in cooling unit of air conditioning system.
2/26/63	7:06	1:07			7:12	15:25		
2/27/63	5:27	:30			10:05	16:02		
2/28/63	9:20	:20			6:24	16:04		
	154:46	67:44	6:21	12:32	126:09	367:32	8	

PART VI

GENERAL LABORATORY INFORMATION

Colloquia

"Computer Programs for Automatic Teaching Devices," by Professor Peter G. Braunfeld, Coordinated Science Laboratory, University of Illinois, February 18, 1963

"A Mathematical Model of the Electrical Activity of the Heart," by Dr. James C. Swihart, IBM Research Laboratory, Yorktown Heights, New York, February 25, 1963

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	15	1	15.0
Visiting Faculty	2	0	2.0
Research Associates	5	0	5.0
Graduate Research Assistants	6	35	23.5
Graduate Teaching Assistants	0	4	2.0
Administrative and Clerical	8	0	8.0
Other Nonacademic Personnel	42	41	60.0
TOTAL	78	81	115.5

The Computer Advisory Committee consists of Professors H. C. Brearley, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During February a total of 136 drawings have been processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	7	4
Medium Drawings	2	4
Small Drawings	0	12
Miscellaneous	8	
Reports	60	4
Change Orders	34	0
P. C. Layout	0	1
	111	25

(J. K. Burrell, K. C. Law)

Physics

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

MARCH 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction

In terms of transistor counts the following progress has been made during March.

Chassis dc checked	2,734
Chassis inspected	150
Chassis wired	253
Chassis layed out	1,645
Printed circuit boards wired (239 boards)	1,227

Cables between the core frame and Advanced Control have been reconnected via 90-ohm ribbon coax terminated in pallet boards. Some preparation has been made for the connection of the external special register lines. These changes have necessitated the modification of a large number of drivers in Advanced Control.

(H. Lopeman)

2. Component Testing

A switching time test rig was built for the evaluation of 2N1072's and possible replacement types. The circuit differs from that in which the 2N1072 is used within the memory, in that constant current rather than constant voltage turnoff drive is used. It is hoped by this technique to display, in an exaggerated way, the device turnoff delay.

A wide range of delays has been found for 2N1072's presently installed. An attempt, thus far unsuccessful, has been made to correlate this

wide variation (4 to 1) with operation in the memory. Tests of possible replacements for the 2N1072 show them all to be inferior to it in this respect.

Acceptance tests have been run on 2200 transistors of various types including 1000 2N967.

Tests of 12,000 1N995 are complete. Of these 91 units failed the 15-volt reverse rating, though 804 units had reverse voltages greater than 40; 49 units were rejected with a forward drop of more than .485 volts at 10 ma.

(B. Doden)

3. Magnetic Drum Memory

On March 19 magnetic drum serial 129 was moved into the computer room and installed in the Magnetic Drum Memory frame. The clock amplifiers were connected and various tests were run on the ten logic chassis, the test chassis and the control panel, all of which had been installed previously. Several problems were discovered and corrected.

The design of the row and column drivers was modified and drawings were sent to the shop for construction.

The first stage of the read amplifier is very sensitive to power supply noise because of the low level signals it handles. A constant current supply and a constant voltage supply were designed to feed it. In an experiment, these preserved normal operation of the amplifier in the presence of one volt of 60 cycles on the +25-volt and -50-volt supplies. Other power supply filtering changes were also made on the read amplifier.

The investigation into optimum write current magnitude and rise time continued. A satisfactory operation point was found to be at a write current of 210 ma peak-to-peak and a current rise time of 0.5 μsec. This gave an N/S ratio of approximately five per cent, where N is the 35-bpi signal remaining after a 280-bpi pattern is written over a 35-bpi pattern and S is the 280-bpi signal amplitude.

At the end of the month the design of all the parts of the repetitive read-write chassis was complete and the drawings were released to the shop for the construction of a one-bit prototype chassis. These parts include

1) Write amplifier

2) Head Selection Matrix, including row and column drivers and read coupling circuit

3) Read Amplifier

4) Peak Detector

After the prototype is built, it will be tested and modified as necessary before the seven final read-write chassis are built.

(H. C. Brearley, M. D. Freedman, B. Levy)

4. Interplay

Circuit modifications to overcome power system noise generation have been completed on the drivers for the address list memory.

(S. Krabbe)

Interplay wiring over the second core position is complete except for indicators and external cabling.

(L. Byers, R. Kingsley)

5. Core Memory

Experiments on the core memory have indicated a beneficial modification to the +65-volt distribution system. This will ensure that the sense amplifier break network diodes are not biased off by transient voltage drops in the distribution system. Work has begun on procurement of parts.

A two-transistor saturating clamp circuit has been tried on the primary of the sensing transformer with some success. This should swamp out some of the history-dependent effects as they are influenced by sense amplifier recovery characteristics. A full-scale installation is being planned and an etched wiring board for the additional parts has been layed out.

(S. R. Ray)

The +65-volt supply was split into X-Y and sense amplifier sections to establish the cause of +65-volt sensitivity. The sense amplifiers were found to be the most sensitive for causes as yet unknown.

(H. Lopeman)

6. The Special Register Distribution System

Logical design has been completed for the Special Register Distribution Point. The system will be described in a forthcoming report.

7. IBM 1401 Interplay Channel

Some rewiring is necessary on the three completed racks of the 1401 module; this has been defined but is not yet done. Intra-rack wiring is defined and ready to be wired on six more racks. Logical design is completed on the last logic rack and is awaiting logic checking. A large amount of time has been spent on reader-punch physical layout; this is the primary cause of wiring delays. Reader-punch is now constructed and is currently being dynamically checked.

8. IBM 1414 Interplay Channel

Logical design of the first tape channel is underway. This logic will occupy ten racks of an 11-rack module; four of these racks have been designed and are ready to be wired.

(R. Miller, M. Pisterzi, R. Willard, Y. Yen)

9. 1401 Cabling

The wiring lists of intra-rack connections for pallet rack, indicator rack and gate driver rack in the 1401 module have been completed.

In order to reduce the total cable length for each generally distributed signal, the word buffering registers are arranged to be in the racks nearest to the pallet boards.

Pallet boards for the 1401 module were designed. Each generally distributed signal is fed to an entrance pallet board, then goes to the new channel via an exit pallet board. Internal wiring will be 90-ohm Teflon twisted pair.

(Y. Yen)

10. NOR Circuit Speed Test

A brief report of operation times which may be expected of NOR circuits (415-116B) and complementary drivers (415-107) has been prepared as File No. 526.

(M. Pisterzi)

PART II

ILLIAC II SYSTEM PROGRAMMING AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Sytems Programs

Double-Precision Input/Output Routines

A double-precision decimal read routine has been written and checked out for Pass 1 of the assembler. A revision has been made to allow it to be used as a part of the system program for input.

Work is being started on a double-precision output routine which will allow a wide assortment of output specifications to be processed.

Logarithm Routines

A subroutine to calculate $\log_{10}x$, $\log_e x$ and $\log_2 x$ has been written and is almost completely checked out.

(M. Gaer)

Trace Routine

Work has begun on the programming of a trace routine. This is a diagnostic routine which will simulate the execution of a program without giving up control to the program. This is done by extracting orders from the program in the order in which they would be executed by the program. Each order is examined and information about the type of order is made available. The trace routine will point out all illegal orders encountered and provide options for the monitoring of accumulator arithmetic, overflow of the accumulator, control transfers, and reference to particular memory locations. There may be other features included.

(F. Schaffer)

Library Programs

Four library programs for the card operating system have been checked out this month. They are:

Square Root

Complex Square Root

Lagrange Six-Point Equal Interval Interpolation

Lagrange Unequal Interval Interpolation

(E. Brower, C. Gear)

Assembler

The three basic passes of the card assembler are complete and checked out. Macros are being incorporated and the input/output and listing programs are being written. These cannot be checked until the 1401 and drum unit are on line.

(H. Jarosch, J. Nievergelt)

Input/Output/Interrupt System

Preliminary versions of the system input/output/auxiliary-storage program (which includes the transfer interrupt routine) are being written in order to study feasibility of various schemes.

(J. Aaron, C. Gear)

Programming Manual

A first draft of half of the manual has been written and typed and is now available for distribution.

(C. Gear)

2. Illiac II Operations

Code Checking		48:16
*Production (Mersenne Primes)		269:16
Engineering Test Routines		
ETR	27:47	
ASMD	2:22	
Duplex Memory	2:40	
OLF	1:50	
Memory Reversing	9:35	
Cross Talk	:50	
		45:04
Demonstrations		5:15
Engineering		176:26
Idle		19:23
TOTAL TIME		563:40

* Does not necessarily indicate actual time in production. First, code checking on this problem is included, and second, since no one is present after midnight, an accurate check of machine operation during this time is not possible.

Errors	
Parity	25
Punch	3
Power Supplies	6
Air Conditioning	1
Unknown	2
TOTAL	37

Bad Components**	
Transistors	25
Diodes	3
Solder Joints	1
Broken Wires	5
TOTAL	34

** Of these components, three transistors and three diodes were spontaneous failures; 16 transistors were removed from memory as a precaution though they were not necessarily at fault; the remaining six transistors and all wire failures were as a result of modifications during new construction.

(W. L. Huffman)

3. 1401 Processing System

All four tape units are now connected to the system and are in operation. Most of the work done with the system is in the nature of code checks.

During the month a 514 Reproducing Punch was received and is now in operation.

(W. L. Huffman)

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Louis van Biljon has started a new project aiming at a clarification of both the experimental and the theoretical aspects of avalanche breakdown of transistors. In particular the collector characteristics are investigated using very short pulses in order to eliminate thermal runaway. Several tentative mechanisms have been invoked to explain the observed $I_C = mI_E + MI_{CO}$ relationship: the fact that $m \neq M$ contradicts all previous theories.

Henry Guckel has studied the performance of his T-line system with several 5 ma tunnel-diodes and has succeeded in producing an input/output impedance ratio of better than two with a voltage gain approaching one up to frequencies of 1 Kmc. These experiments show that it is now possible to build tunnel diodes systems using power amplifiers of high directivity and without reflection to the input. It is felt that this will lead to a multi-kilomegacycle system doing multiplication or counting within very few months.

Sergio Ribeiro has finished the last measurements of flipflop performance: the experimental figures agree fairly well with his phase-plane theory. Thomas Burnside has done some further work on the statistical analyzer and Gabor Ujhelyi has contacted some laser manufacturers. It is felt that the associative memory project should be postponed in order to get the laser work started.

2. Avalanche Effect

Theoretical Investigation

The transport of carriers on the base of a transistor is being analyzed, taking account of increased majority carrier density due to avalanche multiplication.

It is thought that the present view of transistor operation under avalanche conditions is not complete since rather severe discrepancies occur between theory and experiment.

The present way of accounting for avalanche effects is by incorporating a single multiplication factor M in the basic equating, viz.:

$$I_c = M(\alpha_E I_E + I_{co}) \tag{1}$$

where

α_E = normal emitter-to-collector current transfer factor

I_E = total emitter current

I_{co} = base-collector current with emitter open and V_{BC} about 0.5 volt

M = multiplication factor given by Miller, Phys. Rev., Vol. 99, 1955.

Curves of I_c versus V_c shown by Miller and Ebers (B.S.T.J., Sept. 1955), however, do not agree with the above form of the equation. It has been found that a more accurate description will be given by an equation of the form

$$I_c = mI_E + MI_{co} \tag{2}$$

where m is determined by charge conditions in the base and is of the order of 2 to 5; M is as in equation (1) and for the quoted values of m, M could be from about 100 to 1000.

Theoretical justification for the **factor** m, may lie in re-routing of charges in the base due to localized space-charge near the collector or in increased recombination under avalanche conditions or a combination of these and similar effects.

Experimental Investigation

In order to investigate V-I characteristics in the avalanche region, due regard must be taken of thermal effects since dissipation tends to be high under these conditions. It has been found that both dc measurements as well as normal half-sine wave or saw-tooth sweep displays of the V-I characteristic cause excessive dissipation in the base-collector depletion layer. Even small changes in I_{co}, resulting from this dissipation, strongly affect the observed characteristic since M may be of the order of hundreds.

A pulse mode of measurement is thus suggested with say a 50 μsec pulse every 10 milliseconds. The V-I plot can then either be displayed as a series of dots on an X-Y oscilloscope of it can be measured with the bridge circuit shown below. R_4 and R_6 are accurately variable resistances while variation of R_5 provides adjustable V_{EB} bias for different values of V_E.

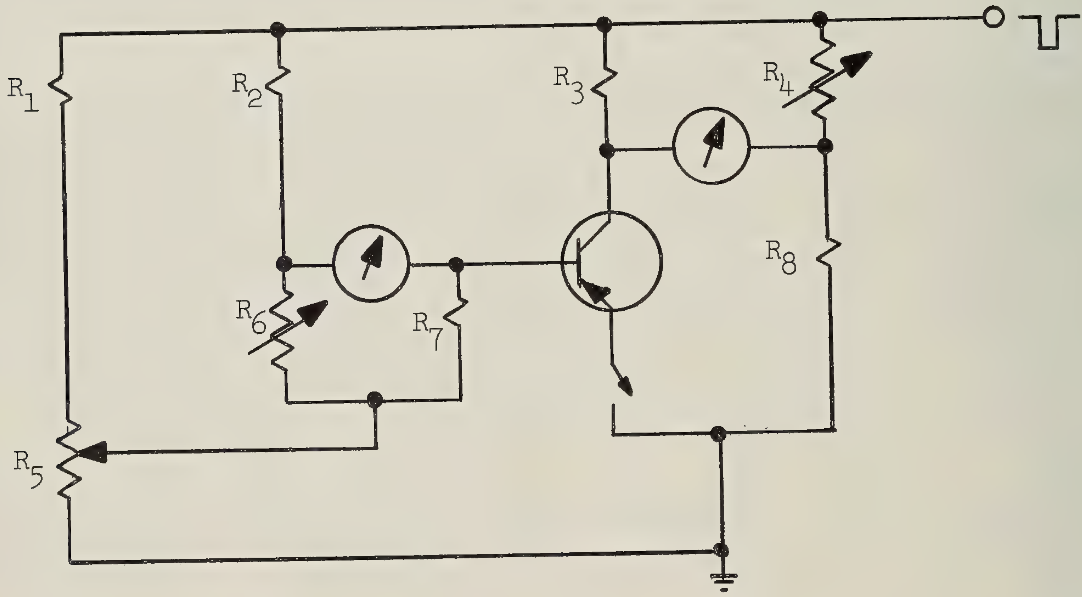

Figure 1. Test Set-Up for Avalanche Effect

For any measurements to be reproducible the environmental temperature of the transistor under test must be accurately controlled. Also, for the calculation of theoretical values, various transistor parameters have to be known at the same temperature as that at which the avalanches measurements are made; parameters such as r'_{bb}, α_E, α_c, I_{cO} and I_{EO} will thus be required at specified temperatures. Considering that M may reach values of 1000 or more, stringent temperature control is necessary.

3. Tunnel Diode Project

Theory

Theoretical studies of the T line are now complete. A program was written for the 7090 to investigate the stability behavior of the different amplifier types. This work is partially complete and should last for another month.

Experiments

Experimental work centered on two projects. The first of these is the actual construction of 30-inch transformers. Attempts to cut through the copper coating with a knife were discontinued when it was found that tolerances of ± 1/32 inch had to be expected after peeling the conductor. The use of tape on the initial boards and subsequent cutting through the tape, peeling and ammonium persulfate etching, yielded unsatisfactory results due to tape deformation in the warm etch bath as well as bubble formation under the tape due to air inclusion. A third method is now under investigation. The board is sprayed with lacquer, which resists the etch bath. Then the four lines are scribed through the lacquer coat, similar to the drawing of parallel lines on paper, and the board is etched. The copper strips are then removed by peeling. The tolerance in this process is about ± 1/64 inch, which is not too good, but will be used in the experiments.

The assembled transformers have now been standardized. This allows the use of a single dielectric cover for all assemblies. This cover is being designed. The material has been received. The entire assembly will be mounted on a 36"-x-6" brass ground plane. The plane has been manufactured and was equipped with four 50-ohm high-frequency pick-offs to allow direct connection of the sampling scope.

Attempts have been made to determine the type of tunnel diode to be used in the actual termination. The deciding factors are the linearity of the negative resistance region, its extent, and the valley region behavior in respect to goto-pair connections. The following typical values were found:

Type	Material	Ip	-R	Range
RCA 3847	Ge	5 ma	-17	100 ± 20 mv
GE 1N2930	Si	5 ma	-47.6	160 ± 60 mv
RCA TD176	Ga As	5 ma	-34.3	200 ± 60 mv

The germanium diode appears to be nearly unuseable. However, some microstate 5-ma Ge diodes seem to be better. The silicon diode was used for comparison only. Due to its high capacitance and low peak-to-valley ratio, it will not be very useful for high frequency service. The Ga As tunnel diode was studied more extensively. Interconnection in the Goto-pair, and optimization of the bias potentials in respect to linearity yielded: -R = -30.4 at 0 ± 110 mv. The linear negative resistor, which results from this circuit has the advantage of being adjustable by a few ohms in either direction. This condition is useful for checking the performance peak of the intercoupled structures. It will be used in the new structures.

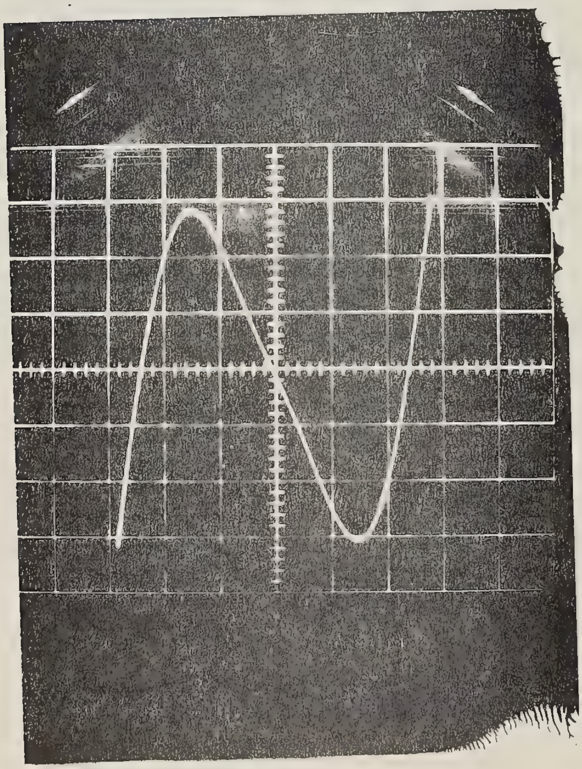

Figure 2. Goto-Pair Performance
Goto-pair (TD176)
I_p = 5 ma
V_{max} = 190 mv

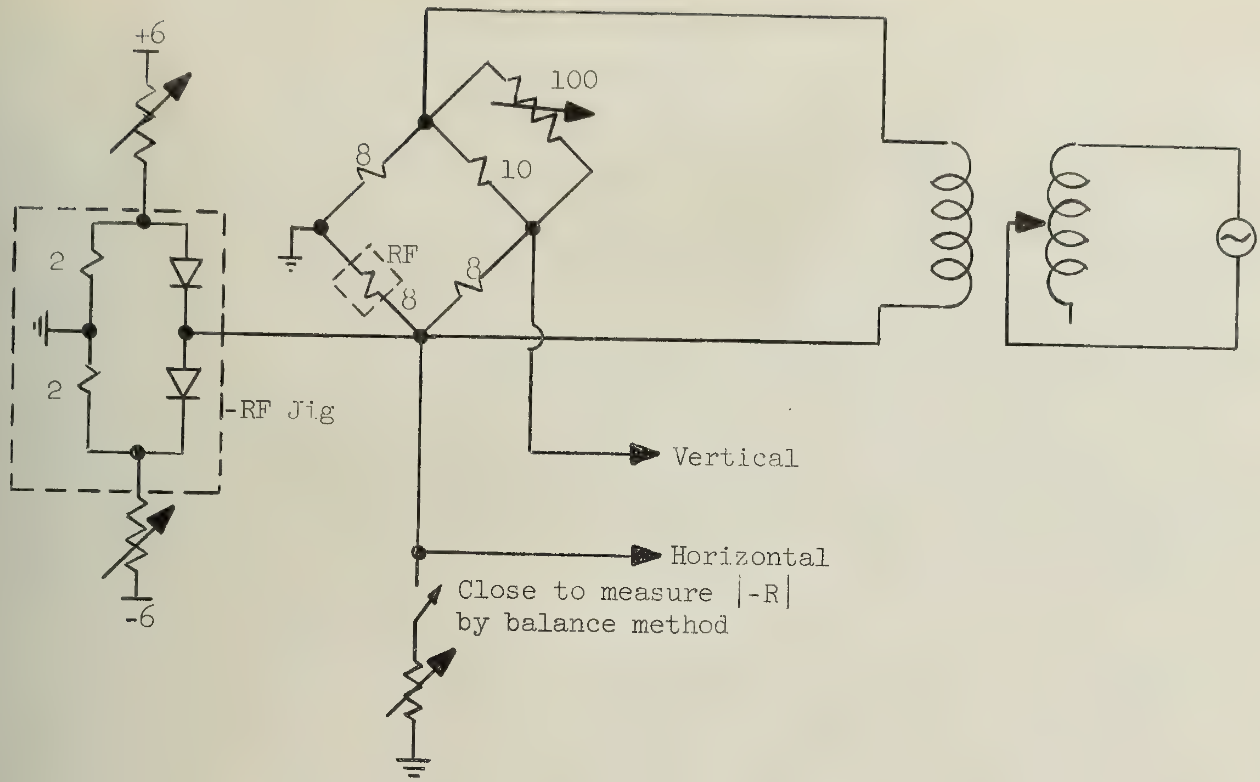

Figure 3. Display Set-Up for Negative Impedances

The assertion that a power amplifier does exist has finally been proven experimentally.

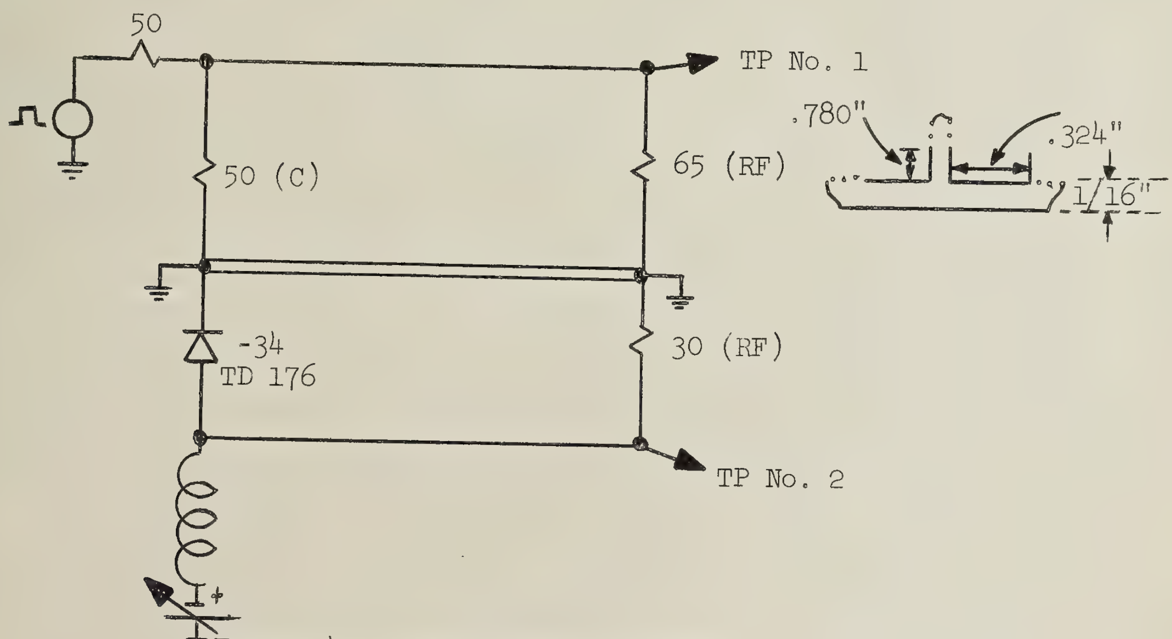

Figure 4. T-Line Power Amplifier

The measured voltage transfer was found to be .775. This means that an experimental power gain of 1.1 occurred. Results indicated a 22.5 per cent error. This was blamed on the line dimension tolerances. With a generator rise time of one nanosecond the rise times at TP No. 1 and TP No. 2 were found to be 1.0 and 1.4 nanoseconds respectively. Since the tunnel diode had a calculated resistive cut-off frequency of 750 mc (1.35 nsec) the rise time decrease can be assigned completely to the diode. Tests with 5 nsec pulse width resulted in completely flat pulses without overshoot.

It was noted that, if the bias was removed from the diode, the pulse transfer decreased to .1. This is being investigated further since it implies the possibility of gating, i.e., directivity control.

PART IV

MATHEMATICS

Mersenne Numbers

A new Mersenne prime, M_{9689}, was discovered by ILLIAC II. The time for the calculation was 1 hour, 25 minutes. This is now the largest known prime number and has 2917 decimal digits. A paper and a report are in preparation which will describe this calculation and also report on a new conjecture about the distribution of Mersenne primes and composites.

(D. B. Gillies)

PART V

IBM 7090-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

During the month of March, two new routines were revised in order to remove errors in the listing. These were:

J5-UOI-SCP3-15-SR — General Alphanumeric Cathode Ray Display

J5-UOI-SCP1-23-SR — General Axes and Point Plotter

(D. Hutchinson)

During the month of March, two new routines were added to the 7090 Library.

C3-UOI-FAC2-27-SR — Floating Point Factorial (FØRTRAN, MAD, SCAT)

This routine provides the floating point value of I!, where I is a fixed point FØRTRAN or MAD integer i.e., $I \cdot 2^{-17}$ or $I \cdot 2^{-35}$ respectively and $0 \leq i \leq 33$.

(D. Hutchinson)

J5-UOI-SCP2-28-SR — FORTRAN Axes and Point Plotter

This routine is simply a version of Library Routine J5-UOI-SCP3-15-SR which has been modified so as to be compatible with the FORTRAN compiler.

(D. Hutchinson)

Research Problem Specifications.

During the month of March, 42 research problem specifications were submitted for the IBM 7090.

279-33004 State Water Survey. Reservoir Capacity. The study involves the analysis of stream flow records at various stations in Illinois to determine an estimate of reservoir capacity necessary to meet certain water requirements during a certain recurrence interval drought.

Stream flow measurements will be used in calculations of moving totals for periods of 1 month to 60 months, a complex sorting on each generated series of totals to determine an estimate of the low flow frequency distributions, and computations to determine reservoir capacity based on the various low flow series.

280-33005T Horticulture. Manganese Toxicity - Soil Phase. The relationships of manganese and calcium in soil columns subjected to prolonged leaching with water (26 cycles of leaching and drying) was studied. Drain tubes situated at various depths down the column enabled the movement of calcium and manganese to be examined under the leaching regime. At the termination of the experiment the columns were dismantled into 9 sections and the soil in each section was analyzed for available calcium and manganese.

The 7090 will be used to complete the statistical analyses (analysis of variance) of the data resulting from the final soil analysis step described above.

281-33006 Electrical Engineering. Simultaneous Equation Solutions. Various methods of solving n equations in n unknowns will be used and possibly applied to sets of simultaneous equations of current-voltage law equations. Various methods will include: Newton, binary chopping, Gauss-Jordan, and Gauss-Seidel

282-33007T Civil Engineering. Integer Valued Linear Programming. This research will involve converting SHARE Library Code "Integer Linear Programming 2, 7090" to use on the University of Illinois 1401-7090 System.

283-33008 Civil Engineering. Concrete Stress Distribution in A Beam Under Pure Flexure. The stress-strain diagram of concrete is usually obtained by a standard cylinder test. This diagram is then used to determine the concrete stress distribution in the compression zone of a reinforced concrete beam subjected to pure flexure. Now, it is apparent that even assuming the stress

in concrete is a function of strain only, this distribution of stresses with respect to strains need not be the same in both cases. In order to clarify this point a series of tests were initiated. The tests at this stage are of pilot nature and their main object is to see whether or not the proposed method of solution will work. This computer program has been written taking this fact into consideration.

The object of the project is to find a curve every point of which has to be computed by rather lengthy formulas. Before the stress at each point can be computed, many complementary computations must be made, most of them having the same character of complexity and length, and all this will have to be done for a large number of tests over a long period of time.

284-33009T Chemistry. Bremsstrahlung Yield Analysis. This computer program is to be used for the analysis of photonuclear reaction yield data obtained from high energy bremsstrahlung irradiations. The information of interest in these experiments is the behavior of the nuclear reaction cross section as a function of photon energy. This information is not directly obtainable from the experiments because the bremsstrahlung beams used contain a continuous distribution of photon energies. The measured yields are related to the cross sections by

$$Y(E_o) = \int_0^{E_o} N(E_o, E)\, \sigma(E)\, dE$$

where $Y(E_o)$ is the yield of the reaction when the maximum energy in the bremsstrahlung spectrum is E_o, $N(E_o, E)$ is the number of photons at each energy in the spectrum, and $\sigma(E)$ is the cross section for the reaction. A set of these yield values taken at several different values of E_o can be used to calculate the cross sections at these energies by applying an unfolding technique. In this method the cross section at energy Em is given by

$$\sigma(E_m) = \frac{E_m}{\Delta} \sum_{i=0}^{m} B(X_m, \Delta, X_i)\, Y(X_i)$$

where $Y(X_i)$ are the measured yield values obtained at energies which are Δ units apart and the $B(X_m, \Delta, X_i)$ are numbers which are related to the bremsstrahlung spectrum. The set of B numbers is different for each E_m at which

the cross section is desired. The IBM 7090 computer will be used first to calculate the necessary B numbers and then to perform the summations needed to calculate the cross sections. Since more than twenty different nuclear reactions are currently being studied here, the availability of this computer program will aid significantly in reducing the time needed for data analysis while also improving the accuracy of the analysis.

285-33010 Agricultural Economics. Commodity Receipts at Chicago. The problem is to estimate the receipts of various commodities received in Chicago by month and type of transportation for 1960 and 1961. The estimates will be made by extrapolation employing a linear regression technique.

286-33011T Geology. Esopus Problem - I. This problem involves variations in minerology and trace elements in Esopus Grit Formation, Kingston, New York Correlation and trend analyses of many different bits of similar and diverse types of data will be made. Some normal distribution statistics and some non-parametric methods will be employed. Data obtained by three distinct and separate methods are being employed (X-ray data, mass spectograph data, and petrographic data).

287-33013 Coordinated Science Laboratory. Networks. The 7090 will be used to analyze some electrical networks, particularly passive networks consisting of resistive, capacitive, and inductive elements. The manner in which these networks are affected by variations in active elements to which the networks might be connected will also be studied. The ultimate goal is to find an optimum manner of connecting these elements to active elements (such as a vacuum tube) as frequency determining elements. Phase, amplitude and impedance characteristics of these networks will be computed, usually as functions of frequency and bandwidth.

288-33014 Digital Computer Laboratory. Grading. The 7090 will be used to grade tests punched on IBM cards in an extremely free format. 1,000 tests can be graded at one time. Each answer can be scored and commented individually. The student receives a printed copy of his answers, his score, and any necessary comments on an answer. The instructor receives a tabulated sheet containing class scores and a frequency list of answers chosen by students.

289-33015 Civil Engineering. Hydrometer Analysis. The physical properties of a soil are affected to a great extent by its particle size distribution. The particle size distribution of a soil can be determined by a standard method -- hydrometer analysis. The basic principle for the hydrometer analysis is Stokes' Law. This program is to be used to perform the long and repetitive calculations.

In connection with the research project Soil Exploration and Mapping, hundreds of hydrometer analyses are performed. This program will provide valuable assistance in data processing.

290-33016 Agricultural Engineering. Efficient Machine Selection. There exists an algebraic formula for the least cost width of farm equipment. The following variables are included: Price/foot width; Field Efficiency; Speed; Acres to be worked; Value of Crop; Timliness factor; Labor cost; and Power cost. This equation is to be evaluated.

291-33017T Astronomy. Plate Reductions: x,y to $\alpha,\delta,\lambda,\beta$. This program computes star positions on the Celestial Sphere, in both the equatorial (α,δ) and ecliptic (λ,β) coordinate systems from measures made in an arbitrary Cartesian coordinate system (x,y) on a photographic plate. The method of reduction is by a least squares analysis of the two equations of condition, evaluated for a number of stars on the plate with known (α,δ) as well as (x,y):

$$\xi - x = U_1 x + U_2 y + U_3 x^2 + U_4 xy + U_5 y^2 + U_6$$

$$\eta - y = V_1 x + V_2 y + V_3 x^2 + V_4 xy + V_5 y^2 + V_6$$

The solution of the least squares analysis gives values of the U_i and V_i $(i=1,2,\ldots,6)$ which are the so called "plate constants." With known coefficients, the (x,y) values of any other star on the same plate may be inserted to obtain values of (ξ,η), from which (α,δ) may be obtained from the equations:

$$q = D + \tan^{-1}(\eta)$$

$$\alpha = A + \tan^{-1}(\xi \cos(q-D)/\cos(q))$$

$$\delta = \tan^{-1}(\tan(q)\cos(\alpha-A))$$

where

ξ = "x-like" standard coordinate

η = "y-like" standard coordinate

α = right ascension of star in question

δ = declination of star in question

A=right ascension of guide star (plate center)

D=declination of guide star (plate center)

q= auxilliary variable

Conversion of (α,δ) to ecliptic longitude and latitude (λ,β) is accomplished by means of a subroutine which carries out the transformation equations which are:

$$\eta = \tan^{-1}(\tan(\delta)\sin(\alpha)) \quad \beta = \sin^{-1}(\sin(e+n)\sin(\delta)\sec(n))$$

$$\lambda = \tan^{-1}(\sin(e+n)\tan(\alpha)\csc(n))$$

where:

n = auxilliary variable

e = inclination of ecliptic-to-equatorial planes

β = ecliptic latitude

λ = ecliptic longitude.

The method involved is completely independent of the type of telescope used to take the photographic plates; also, it is independent of the units in which (x,y) are measured as long as the same unit of measure is used for all measures made on the same plate.

292-33018T Astronomy. Light Travel Times. In an observing program concerning variable stars, it is necessary to time all observations with respect to the center of the Sun in order to eliminate systematic effects in light travel-times due to the orbital motion of the Earth. The purpose of this program is to compute and print out a table of time corrections (in decimals of one mean solar day) to convert geocentric to heliocentric time. The program computes values of the time-difference, Δt, for different arguments of ecliptic longitude, $0^{\circ} < L < 360^{\circ}$, and ecliptic latitude, $0^{\circ} < B < 90^{\circ}$, by the function:

$$T = 10^{4}\Delta t = \frac{a}{8.64\ c}\cos L \cos B,$$

where:

a = semi-major axis of the Earth's orbit,

c = speed of light.

Many different values of L and B are used since not only are these arguments different for every star, but also the ecliptic longitude of the sun changes throughout the year. Entry to the table - body (T) is made by finding the B for a particular star and the difference between its ecliptic longitude and the Sun's, the difference being L.

293-33019 Digital Computer Laboratory. Gamma Ray Transition Matrix. This is a theoretical calculation to test the validity of the Weisskopf and Moszkowski Matrix elements of the γ - transition matrix for nuclear isomeric states against experimental data. Modifications of these elements will then be sought to enable them to better predict nature.

294-33021 Institute of Communications Research. Cross-Cultural Project. The research for which the 7090 is to be utilized is a systematic cross-linquistic and cross-cultural investigation of human systems designed to test the limits of possible generality of such systems and to investigate problems in human cognition more generally. Sixteen language and culture groups are presently under study.

The IBM 7090 will specifically be used to compute product-moment correlations, factor coefficients and rotational factor coefficients. Related factor analytic techniques will be employed from time to time. Such calculations are to serve to identify the underlying structures in subject ratings of the inter-relatedness of extended samples of qualification modes in each of the sample languages. The experimental design calls for multiple replications of the determination of such inter-relatedness with changing subject, item and judgemental tasks. Ancillary calculations of standard measures of reliability, variance estimates and the like will also be required. Estimates of the productivity of established word association procedures in each language group, including the calculation of Information Theory entropy measures are currently being calculated on standard card equipment but may be transferred to the 7090 facilities when efficient procedures are devised.

295-33023T Civil Engineering. Moment-Load-Curvature for Box Section. In order to find the ultimate strength of a column subjected to eccentric loads, it is necessary to know the relation between moment and curvature with an axial load acting on the column cross section. In this problem the section being considered is a hollow rectangle with constant wall thickness.

When the stress-strain relation for the material is non-linear, the evaluation of the integrals needed to relate the quantities is difficult. The IBM 7090 can be used to determine the values at enough discreet points to describe the relation. In this program the stress-strain curve is made of two linear portions and only simple algebra needs to be used.

The reduction in stiffness about the weak axis due to plasticity caused by strong axis bending is also found in this program.

296-33024T Chemistry. Tubular Reactor Analysis. This problem involves an analysis of the transient behavior, stability and control of tubular chemical reactors. Numerical solutions of the non-linear differential equations describing heat ant mass transfer will be obtained.

297-33028 Industrial Education. Ethnic Origins and Educational Recruitment. The Alaskan Village survey, conducted in 1958, has provided data on 29,000 natives. This represents an opportunity to analyze the relationship between ethnic origins and recruitment into education in the only remaining non-industrial societal group in the United States. The 7090 computer provides the speed necessary for covariant analysis of the large body of data.

298-33029 Agronomy. Response of Soybean Varieties to Soil Fertility. The purpose of this problem is to find soybean lines or varieties which have the capability of giving large responses to increases in soil fertility. Any such lines or varieties might then be utilized in a plant breeding program to develop varieties which can make advantageous use of high fertility levels.

Several experiments involving a large number of soybean varieties and several phosphorus and potassium fertility levels have been conducted. Factorial analysis of variance procedures will be utilized to analyze the data. An appropriate IBM 7090 program has been written for this purpose.

299-33030T Agronomy. Soil Productivity Study. This investigation of the productivity of Flanagan silt loam and Drummer silty clay loam under different management and weather conditions is being made in order to determine the effects of weather and management practices on crop yields. The crops under study are corn, oats, soybeans, and wheat. Two samples of twenty-five farms

each will be studied for the period 1953-62. Sixteen weather variables and eleven management variables will be analyzed for each farm for each year. Multiple regression and correlation techniques will be used to find the net effect of each variable on crop yields. In addition, a total regression equation will be found. The total regression equation will be used as a yield predictor.

300-33032T Civil Engineering. A Probabilistic Approach to Rational Seismic Design. Studies towards the establishment of a rational basis for the design of structure to resist earthquakes have been made using two approaches: deterministic and probabilistic.

In the probabilistic studies made thus far certain idealizations have been used in the representation of the ground motion. These idealizations seem to be rather arbitrary and bear almost no resemblence to the existing earthquake records.

In the proposed study an ensemble of time functions will be formed from the existing strong motion earthquake records, and the following studies will be performed: the records will be "balanced," the random process will be studied for stationarity and normality. Based on the assumption that the random process is a normal process, the first order probability density function of a single degree of freedom linear damped oscillator subjected to this random process will be determined. From the information provided the damped and undamped deformation spectra corresponding to constant probability of failure will be determined, and the variation of such spectra with the damping parameter will be studied.

301-33033 Physics. Spark Chamber Analysis. The decay of neutral K-mesons into three particles is being studied by photographing the tracks made by the decay particles in spark chambers in a magnetic field. Measurements of points on the photograph are made by a Hydel measuring machine. From the measurements, the computer must reconstruct the decay in space and analyze the decay in terms of the momenta and angles of the decay products. Approximately 10,000 events require analysis.

302-33034T Aeronautical and Astronautical Engineering. Characteristics Program. A numerical method of characteristics solution for three-dimensional, non-steady gas flows will be programmed. Solutions will be written for each of three unit processes: the field point, the body point, and the shock point.

303-33035T Mechanical Engineering. Carbon Forming Prediction of Hydrocarbon Fuels. It is proposed in this research project to develop a method of predicting the carbon-forming characteristic of a hydrocarbon fuel when burned under various conditions. The method is based on the characteristic equation of diffusive motion and will take into account such variables as pressure, temperature, ignition delay period and fuel-air ratio.

304-33036 Digital Computer Laboratory. Nonlinear Coupled Oscillators. A system of nonlinearly coupled harmonic oscillators will form a one dimensional lattice and the ends of the lattice will be placed in contact with reservoirs of different temperature. The transfer of energy from one reservoir to the other will be studied as a function of the size of the nonlinear term and the equipartition of energy over the Fourier modes of the lattice will be observed. This is a continuation of a problem started on MANIAC I at Los Alamos in 1952.

305-33037 Theoretical and Applied Mechanics. Stress Analysis of Notched Plate. The 7090 will be used in calculating the values of $I_{n,r}$ which is defined as (n=1 to 19, r=0 to 19)

$$I_{n,r} = \frac{1}{2n\pi} - \frac{2r + 3 - 2n}{4n} I_{n-1,r}$$

$$\text{given } I_{o,o} = 0.156914$$

$$\pi = 3.141592$$

Also involved is the solution of ten simultaneous equations with ten unknowns.

306-33038T Astronomy. Extinction Values and Time Factors. This program computes a table of photographic extinction values (Δm) and time factors (f) for use in astronomical photography. The purpose of the table is to allow the observer to adjust exposure times at the telescope, so that the stellar images on the photographic plate will be all of the same size (linear, on the plate) as they would have been if they were all at the observer's zenith. Since the zenith distance (z) of a particular star is a function of the star's declination (δ) and hour angle (t), the table uses these quantities as the variable arguments. The zenith distance also depends upon the observer's latitude (ϕ); hence, this table is intended for use exclusively at the University of Illinois Observatory (ϕ = +40°06'20.2"). Two copies of the completed table (OUTPUT) are needed, since two telescopes at two different locations will be in use. The "Δ m" and "f" are computed from the following formulae:

$$\cos(z) = \sin(\phi)\sin(\delta) + \cos(\phi)\cos(\delta)\cos(t)$$

$$z = \tan^{-1}\left(\frac{(1-\cos^2(z))^{1/2}}{\cos(z)}\right) = \tan^{-1}\left(\frac{\sin(z)}{\cos(z)}\right)$$

$$\Delta m = 0.268\left(\frac{1-\cos(z)}{\cos(z)}\right) = 0.268(\sec(z) -1)$$

$$f = \exp(1.098612\ \Delta m)$$

307-33039T Electrical Engineering. Characteristics of Periodic Structures. The purpose of this research is to determine the propagation characteristics and near fields of a class of periodic structures. This knowledge has applications in the field of antenna engineering.

The propagation characteristics are to be determined by solving secular equations of the form $f(\beta,k) = 0$. The fields can be determined by direct computation. All expressions to be programmed involve sums of products and ratios of infinite products.

The program involves complex arithmetic operations.

308-33040 Digital Computer Laboratory. T-Line. Intercoupled transmission lines with negative resistance terminaations have been treated analytically. If the negative resistors are replaced by tunnel diodes, the diode capacity results in mismatch and stability problems. The computer is used to study incident and reflected waves at different frequencies. It computes the input

impedance of the sending line and thereby allows the use of the Nyquist stability criterion.

Cosine and sine routines are used to calculate determinant entries from values of the data. The evaluation uses closed subroutines for complex multiplication and complex addition and a macro-instructions for evaluating minors. Results are printed out for each specified frequency value.

309-33041 Mathematics. Stilbestrol Dose Response Curve. A study of the carcenogenic dose-response curve to oral stilbestrol will be made through statistical analysis.

The experimental data is to be reduced by a Fortran program and then analyzed by a multiple regression program.

An attempt has been made to reduce the experimental data on the IBM 1401, but the storage capacity of the IBM 1401 proved too small for the arrays involved.

310-33042 Communications. Pattern Synthesis. An attempt will be made to produce argorithms which will describe drawings (Flow Charts, etc.) and will permit them to be read into the machine. Output will be the same drawings or a representation of these drawings which will be symmetrical and easy to read.

311-33043 General Engineering. Technician Need Study. This research project is a technician need study in Vermilion County, Illinois. This involves collection and analysis of approximately 150 bits of information on each of several hundred technicians. Cross tabulation and correlation analysis can be run on the IBM 7090 with a significant saving of time.

312-33044 Civil Engineering. Eigenvalues of a Non-Symmetric Matrix. The nature of this research is to study and to solve an eigenvalue problem having a non-symmetric matrix. At first, the determinant of a matrix is expanded by the Krylov method, then all eigenvalues and eigenvectors are computed by using two standard library subroutines. Secondly, an iteration technique is chosen to determine the dominant eigenvalue. The intermediate eigenvalues are obtained next by iteration through biorthogonality. The convergence and accuracy of such a method will be studied in the final phase of this research.

313-33045T Labor and Industrial Relations. Human Relation Training Effects. The study consists of an evaluation of the effects of two courses in the College of Commerce and Business Administration in terms of attitude change of the students. The courses, Business Administration 510 and Management 312, have human relations in industry as their primary content. The IBM 7090 will be used to perform a statistical analysis of the change from pre-test to post-test on a number of scales and to construct a matrix of intercorrelation between these same scales.

314-33046 Agricultural Engineering. Watershed Data Processing. The computer will be used to process rainfall-runoff data from experimental watersheds. It will preform the numerous time consuming algebric computations associated with such analysis.

315-33048 Electrical Engineering. Transmitter Research. The 7090 will be used to make tables of inductor and capacitor values for the tank circuit of a fifty megacycle transmitter. The main use of these tables will be to facilitate the application of available parts to efficient practical design.

316-33049T Education. The Effects of Rope Jumping on the Endurance, Leg Power, Agility and Coordination of Children in the Intermediate Grades. The purpose of this study was to determine the effects of jumping rope five minutes daily for eight weeks on the endurance. Leg power, agility, and coordination of boys and girls in grades four, five, and six. The experimental group included 45 fourth graders, 41 fifth graders, and 40 sixth graders. The control group included 25 fourth graders, 26 fifth graders, and 29 sixth graders. The subjects were pre-tested and post-tested in measures of endurance, leg power, agility, and coordination. For each subject, age in months and IQ (California Mental Maturity) were obtained from school records. For subjects taking the endurance tests, measures of height and weight were taken from school health records.

The statistical analysis proposed for the data is analysis of covriance of scores in endurance, leg power, agility, and coordination. A multiple correlation will be carried out on the data -- age, grade level, sex, IQ, height, weight, and the four sets of pre-and post-test scores.

317-33052T Mechanical Engineering. Rotating Disk in Slip Flow. An experimental investigation is being undertaken to verify the application of the Navier-Stokes equations with slip boundary conditions for a rotating disk system. The IBM 7090 will be used to reduce the experimental data and compile the parameters necessary to describe this type of slip flow.

318-33053 Astronomy. Reduction of Cluster Counts. This program computes the radial density function of a spherical stellar system given the number of stars, N, contained in an annulus with mean radius "r" and width "Δr". The densities and radial coordinates are computed, in units of square minutes of arc and minutes of arc respectively, and converted to logarithms by means of the ELOG library subroutine. Provision is made in the data cards to identify the particular plate on which a system is found, the plate scale, the name or catalogue number of the system itself, as well as the quantity to be used for the background determination which is subtracted from the raw densities in order to separate the density distribution of the system alone from that of the background (assuming a uniform background over the area of the sky covered by the stellar system). The pertinent formulae are the following:

$$f' = \frac{N}{\pi (S/60)^2 2r \cdot \Delta r}$$, where f' = raw density function
S = plate scale

$$\sigma_{f'} = f'/(N)^{1/2}$$, where $\sigma_{f'}$ = mean error (Poisson)

$$f = f' - f_B$$, where f = true radial density function of system

f_B = background density

$$r_m^2 = (S/60)^2 \left((r + 1/2 \Delta r)(r - 1/2 \Delta r) + 1/2 (\Delta r)^2\right),$$

where r_m = mean radius of annulus (min. of arc)

$$\sigma_{\log f} = \sigma_{f'}/2.303 f$$, where $\sigma_{\log f}$ = mean error of "log f"

The results ($f' \pm \sigma_{f'}$, f, $\log f \pm \sigma_{\log f}$, $\log r_m$) are printed out in a table, which is used finally to plot $\log f \pm \sigma_{\log f}$ vs: $\log r_m$.

319-33054 Mathematics. Generalizations of Bessel Functions. A study will be made of the properties of several generalizations of n-th order Bessel Functions. Three types will be studied: A generalization of Bessel's differential equation, a generalization of the integral form, and a generalization of the series representation.

For each of these equations, an analysis of periodicity, recurrence relations, and other properties will be made. The Cathode Ray Tube will be used to provide graphs of the solutions. Tables of values will be computed.

The primary compiler to be used will be MAD, for speed of compilation.

320-33055 Statistical Services Unit. Medical School Student Attrition Study. The purpose of the proposed study is to make a detailed analysis of the problem of medical student attrition in order to develop recommendations and means through which medical schools might significantly lower their attrition rates. Regular admission and progress data is available for all U. S. medical schools in the central records of the Association of American Medical Colleges. Complete and accurate analysis of these records requires massive data handling procedures for ordering, searching, and collating approximately 80,000 individual records covering the last 10 years of medical student activity. Attempts to search these data in the past to develop accurate statistics on attrition rates have led to equivocal results. Use of the IBM 7090 will allow complete identification of all possible student progress patterns along with precise data on their frequency.

Instructional Problem Specifications

During the month of March, 6 instructional problem specifications were submitted for the IBM 7090.

I52-33001 Civil Engineering 391. Problem 2. Grade Elevation. The purpose of this problem is to teach the students iteration methods and input/output procedures.

I53-33002 Civil Engineering 391. Problem 3. Spillway Design. The purpose of this problem is to acquaint the students with numerical integration, trial and error procedures, subroutine applications, and plotting.

I54-33003 Civil Engineering 391. Problem 1. Traverse Closure. The purpose of the problem is to acquaint the students with the University of Illinois operating system.

I55-33022 Chemistry and Chemical Engineering 490. Problem 2. Matrix Multiplication. Write a subroutine to multiply two $\underline{N}$ x $\underline{N}$ matrices together. Write a driving program for code-checking purposes which will read $\underline{N}$, (I4), and two matrices (4F20,8), compute the product via your subroutine, print out both input matrices and their product, and start over. Save all index registers you use in the subroutine, and do not use any index registers other than 1, 2, and 4.

I56-33025 Mathematics 195. Problem 2. Series Approximation to $\mathrm{LOG}_{10}X$, X = 1 (1) 10. Write a SCAT language program using floating-point arithmetic to calculate F(X) where

$$F(X) = 1/2 + \sum_{i=0}^{3} C_{2i+1} \left(\frac{x - \sqrt{10}}{x + \sqrt{10}} \right)^{2i+1}$$

with

$$C_1 = 0.86855434,$$
$$C_3 = 0.29115068,$$
$$C_5 = 0.15361371,$$
$$C_7 = 0.21139497,$$
$$\sqrt{10} = 3.1622776602.$$

Print a table of X and F(X) for X = 1 (1) 10. F (X) is an approximation to $\log_{10} X$.

I57-33031   Aeronautical and Astronautical Engineering 241. Problem 1. Short Range Missile Trajectory. The problem consists of solving the non-linear differential equations for a missile operating in the atmosphere. The equations of motion are highly simplified. The trajectory is planar, and a flat, non-rotating constant gravity earth is assumed. For ease of programming and minimizing machine time, only a first order difference scheme is used for the integration.

Information on the utilization and reliability of the IBM 1401 and IBM 7090 for the month of March, 1963 is given in the tables on the following pages.

TABLE I - IBM 1401

SUMMARY OF USE

MARCH 1963

Scheduled Engineering	6:50
Unscheduled Engineering	21:59
Cleaning printer, tapes	2:47
7090 preparation	320:38
Tape labeling	1:15
Deck reproduction	1:29
Listing	11:42
Code checking	7:25
Tape listing	9:13
CDC preparation	:04
Tape dump	3:06
Tape copying	:55
Respooling tape	:35
Share Library Program dumps	:15
Monthly reports	1:44
Idle	22:37
	412:34

TABLE II - IBM 1401

SUMMARY OF MACHINE ERRORS

MARCH 1963

1401 Main Frame	5
1402 Reader-Punch	1
1403 Printer	6
729V Tape Units	2
Total Errors	14

TABLE III

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	IDLE	TOTAL RUNNING TIME	ERRORS	IBM 1401 DAILY TIME DISTRIBUTION
3/1/63	16:39		:25		17:04	1	(1) 1401 failed to read labels on input tapes. Trouble found to be in program.
3/2/63	3:00				3:00	1	(1) Tape unit A did not come out of a high speed rewind.
3/4/63	16:45	3:20			20:05		
3/5/63	20:05				20:05		
3/6/63	15:37		2:55	1:13	19:45	1	(1) 1401 failing to detect binary cards. Engineers tightened brush No. 1 in 1402 reader, installed new card in bit test equal compare circuit.
3/7/63	14:56		:25	4:25	19:46	1	(1) Binary cards still loading incorrectly on tape.
3/8/63	13:40		3:04	:55	17:39	1	(1) Fuse blown on 1402 Punch. Replaced.
3/11/63	16:46				16:46		
3/12/63	15:24		1:05	:05	16:34	1	(1) Carriage ran away on 1403 printer. Suspected bad brushes in carriage control. Brushes replaced.
3/13/63	11:30		6:30	2:05	20:05	1	(1) Engineers checked for binary trouble, and could not get failures to repeat. Trouble not found.
3/14/63	18:18			1:29	19:47		
3/15/63	16:33		:45	2:37	19:55	1	(1) 1403 Printer would not eject paper. 1401 turned off at 2345 on 3/15/63.
3/18/63	12:15		2:35	1:10	16:00	1	(1) Engineer called at 0800 on 3/18/63 and found broken valve stem in 1403 carriage control. The part was sent from Springfield and replaced.
3/19/63	20:00		:25	:05	20:30	1	(1) Carriage ran away in 1403 printer. Trouble cleared up by itself.
3/20/63	19:02			:55	19:57		
3/21/63	17:20			2:35	19:55		
3/22/63	17:09			3:03	20:12		
3/23/63	4:21				4:21		
3/25/63	15:25			1:25	16:50		
3/26/63	20:12		:05		20:17	1	(1) 1403 printer ribbon runs off track. Trouble corrected itself.
3/27/63	16:44	3:30			20:14	1	(1) Checked Column No. 1 for binary trouble, but nothing found. Did general maintenance.
3/28/63	15:30		3:45		19:15	1	(1) Carriage ran away on 1403 printer. Engineer tightened nut on hydraulic unit and did general maintenance.
3/29/63	20:20			:35	20:55	1	(1) Tape Unit 'B' damaged a tape when it did not come out of a high speed rewind.
3/30/63	3:37				3:37		

TABLE I - IBM 7090

SUMMARY OF USE

MARCH, 1963

Scheduled engineering	30:24
Unscheduled engineering	20:25
System updating	2:43
Production (see Table IV)	203:07
Idle	101:10
TOTAL	357:49

TABLE II - IBM 7090

SUMMARY OF MACHINE ERRORS

MARCH, 1963

Arithmetic Unit	5
729VI Tape Units	5
C.R.T.	5
711 Reader	1
721 Punch	5
716 Printer	4
TOTAL ERRORS	25

TABLE III - MARCH 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	IDLE	TOTALS	ERRORS	IBM - 7090 DAILY TIME DISTRIBUTION
3/1/63	10:31	:45		5:39	16:55		
3/4/63	10:55	1:30	:07	3:40	16:12	1	(1) 716 clock keeping improper time. Burned point in relay replaced.
3/5/63	7:32	2:10		6:28	16:10		
3/6/63	9:11	1:15	:12	5:38	16:16		Checked Tape unit 'T' on line. No trouble found.
3/7/63	2:59	1:10	10:36	1:15	16:00	2	(1) Address register position No. 9 failed to reset. Defective relay found and replaced. (2) Card jam in reader.
3/8/63	14:04	1:23		3:18	18:45	1	(1) Card reader making errors.
3/11/63	8:44	1:00	:04	6:33	16:21	1	(1) 716 clock keeping improper time. Burned point in relay found and replaced.
3/12/63	7:43	1:45	:10	6:11	15:49	4	(1) Tape unit 'T' broke tape. (2) Tape unit 'T' broke tape. Taken off-line. Unit adjusted. (3) Bad tube in CRT found and replaced. (4) Tape unit 'Y' broke a tape coming out of a high speed rewind.
3/13/63	8:02	1:11		6:36	15:49		
3/14/63	10:19	1:00	1:30	3:29	16:18	1	(1) Checked machine error that has been occuring randomly. Could not find error.
3/15/63	11:18	1:00		4:51	17:09	1	(1) CRT drops off "ready." CRT taken off-line. CRT put back on line after balancing the amplifiers.
3/18/63	9:35	2:00		4:25	16:00		
3/19/63	9:51	1:10	:12	4:56	16:09	1	(1) Tests started printing out error notes. Master tape would not load. Sense indicator No. 11 bad and replaced. Installed Engineering changes.
3/20/63	9:24	2:45		3:51	16:00		
3/21/63	9:09	1:05	3:16	3:54	17:24	5	(1) Broken wire found and fixed in CRT. (2) Printer misses one character. (3) 721 Punch misses one column. Found and replaced bad circuit card. (4) Punch laces cards in column No. 11. (5) Printer puts wrong characters in Column No. 11. Found bad card in Channel A and wires shorted. Engineers continued engineering the following day.
3/22/63	10:48	1:10	:51	6:18	19:07	2	(1) 716 printer failed to eject paper. Cleaned contact brushes, but trouble was caused by wrong control panel in printer. (2) System looping. Failed to shift left accumulator 9 bit to 8. Bad card found and replaced.
3/23/63	3:55				3:55		

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	IDLE	TOTALS	ERRORS	IBM - 7090 DAILY TIME DISTRIBUTI
3/25/63	9:58	1:00	2:10	2:52	16:00	2	(1) Loose screws in tape unit 'S'. (2) Attempted to build a master II 5 times with 5 different results. Could not get a final correct version.
3/26/63	11:20	1:00		7:36	19:56		Successfully made a master tape II which failed on 3/25/63.
3/27/63	9:59	2:15		3:46	16:00	1	(1) CRT Recorder overloaded and heated up. Turned off CRT. CRT taken off-line. Switch on camera adjusted and CRT put back on-line.
3/28/63	8:51	:40		6:43	16:14		
3/29/63	8:22	3:10	1:17	3:11	16:00	3	(1) Tape Unit 'U' taken off-line for general maintenance and cleaning and then put back on line. (2) Burned relay found and replaced in on-line punch. (3) Interlock found open on 721 punch.
3/30/63	3:20				3:20		
Total	205:50	30:24	20:25	101:10	357:49	25	

TABLE IV - IBM 7090
USE BY DEPARTMENTS - MARCH 1963

Department	Number of Runs				Number of Problem Specifications				Time Used			
	Class	Research	Non system	Total Number of Runs	Class	Research	Non system	Total Number of Prob. Spec	Class	Research	Non system	Total Time Used
Agricultural Engineering		62		62		2		2		1:12		1:12
Agricultural Economics		34	7	41		4	3	7		:13	1:26	1:39
Agronomy		53		53		10		10		:53		:53
Astronomy		25		25		3		3		:09		:09
Civil Engineering	317	664		981	6	28		34	1:47	28:07		29:54
Ceramic Engineering		1		1		1		1		:01		:01
Chemistry	22	927	1	950	2	27	1	30	1:29	22:19	:25	24:13
Communications		101		101		2		2		:35		:35
Coordinated Science Laboratory		6		6		1		1		:04		:04
Digital Computer Laboratory	105	688	37	830	1	19	5	25	:48	22:31	29:01	52:20
Dairy Science		24		24		1		1		:32		:32
Economics		14		14		1		1		:33		:33
Education		14		14		4		4		:35		:35
Electrical Engineering	318	278		596	7	13		20	5:32	4:16		9:48
General Engineering		2		2		1		1		:04		:04
Geology		21		21		2		2		2:20		2:20
Graduate School of Business Administration		7		7		1		1		:09		:09
Horticulture		4		4		1		1		:02		:02
Institute of Communications Research		30		30		2		2		:23		:23
Industrial Engineering	19	12		31	2	1		3	:12	:16		:28
Instructional TV		76		76		3		3		1:40		1:40
Mathematics	1619	2		1621	4	1		5	5:36	:01		5:37
Mechanical Engineering	6	317		323	1	16		17	:04	7:06		7:10
Marketing		5		5		1		1		:04		:04
Mining, Metallurgy and Petroleum Engineering		82		82		3		3		:34		:34
Men's Residence Hall Association Rocket Club		47		47		1		1		1:05		1:05
Music		49		49		1		1		1:00		1:00
Nuclear Engineering		25		25		1		1		:31		:31
Office of Instructional Research		8		8		1		1		:12		:12
Physical Education for Women		[illegible]		[illegible]		[illegible]		[illegible]		:28		:28

Department	Number of Runs				Number of Problem Specifications				Time Used			
	Class	Research	Non system	Total Number of Runs	Class	Research	Non system	Total No. of Prob. Spec.	Class	Research	Non system	Total Time Used
Physics	143	754	1	898	2	22	1	25	3:07	23:47	:37	27:31
Plant Pathology		8		8		1		1		:05		:05
Psychology		261		261		19		19		7:45		7:45
State Geological Survey		16		16		1		1		:56		:56
Small Homes Council, Bureau of Residential Construction		18		18		1		1		:36		:36
Sociology		24		24		1		1		:35		:35
Statistical Services Unit		255	1	256		2	1	3		13:00	:48	13:48
State Water Survey		99	1	100		5	1	6		1:36	:25	2:01
Theoretical and Applied Mechanics	5	216		221	1	10		11	:03	5:04		5:07
Veterinary Medical Science		1		1		1		1		--		--
Sub totals	2554	5236	48	7838	26	216	12	254	18:38	151:19	32:42	202:39
Instruction		47		47		1		1		:28		:28
Grand Totals	2554	5283	48	7885	26	217	12	255	18:38	151:47	32:42	203:07

PART VI

GENERAL LABORATORY INFORMATION

Colloquia

"The Transmission of Signals and Computation by Means of Imperfectly Timed Elements," by Dr. Robert F. McNaughton, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania, March 4, 1963

"Cauchy's Method of Minimization," by Dr. Allen Goldstein, Computation Center, Massachusetts Institute of Technology, Cambridge 39, Massachusetts, March 11, 1963

"Experiences with Parallel Remote Console Computer Operation," by Dr. Alan J. Perlis, Head, Department of Mathematics, Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pennsylvania, March 18, 1963

"Numerical Integration in Two, Three, and Four Dimensions by Direct Methods," by Dr. Donald H. Secrest, Instructor in Chemistry, University of Illinois, March 25, 1963

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	15	1	15.5
Visiting Faculty	3	0	3.0
Research Associates	4	1	4.5
Graduate Research Assistants	6	35	23.5
Graduate Teaching Assistants	0	4	2.0
Research Engineer	1	0	1.0
Administrative and Clerical	8	0	8.0
Other Nonacademic Personnel	40	56	63.5
TOTAL	77	97	121.0

The Computer Advisory Committee consists of Professors H. C. Brearley, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During March a total of 134 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	6	2
Medium Drawings	0	0
Small Drawings	5	1
Reports	44	20
Change Orders	25	0
Printed Circuits	0	10
Miscellaneous	21	0
TOTAL	101	33

(J. K. Burrell, K. C. Law)

DIGITAL COMPUTER LABORATORY

UNIVERSITY OF ILLINOIS

URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM

PART II - ILLIAC II SYSTEMS PROGRAMMING AND OPERATION

PART III - CIRCUIT RESEARCH PROGRAM

PART IV - MATHEMATICAL METHODS

PART V - DATA REDUCTION METHODS

PART VI - IBM 7090-1401 SYSTEM

PART VII - GENERAL LABORATORY INFORMATION

APRIL 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction

In terms of transistor counts the following progress has been made during April.

Chassis dc checked	3,137
Chassis inspected	0
Chassis wired	425
Chassis laid out	1,220
Printed circuits (175 boards wired)	1,059

Mechanical framing for the first Interplay channel has been prepared for back-panel wiring. The console structure has been delivered and is ready for installation of equipment. Interplay main frame wiring is now complete.

2. Component Testing

Tests of ten units each of all small transistors used in the machine have been run in order that "typical" data sheets can be prepared for the reverse current tester.

Detailed data has been taken on about 200 transistors and 100 diodes. Acceptance tests have been run on 3,200 transistors and 5,100 diodes.

(B. Doden)

3. Interplay

The drum channel control has been rechecked, after several idle months, by means of the drum simulator. The drum itself was run to a limited extent.

The remainder of Interplay has been checked briefly. Examination of detailed signal levels, improper timing and parity errors remain. All preparation for the next channel is complete.

(S. P. Krabbe)

The design of an Interplay channel device simulator as described in S. P. Krabbe's memorandum of April 24 has been completed. The checking of R. R. Shively's Interlock is nearing completion.

(B. Briley)

4. The Special Register Distribution System

Layout and rack wiring were completed this month. The system was described in a report, which included logical and circuit requirements of special registers to be built in the future (File No. 527, "The Special Register Distribution System").

(R. Willard)

5. IBM 1401 Interplay Channel

The wiring lists of intra-rack connections and cross-rack connections for the 1401 module have been completed. Intra-rack wiring on nine racks has been completed.

Considerable time was spent attempting to devise a set of symbols which would enable the designer to specify printed circuits and printed-circuit boards with minimal paperwork.

The numbers of various printed boards used in the 11 racks of the 1401 module are listed in the following table.

Circuit's Name	No. of Circuits/Board	No. of Boards Used
Word Buffer	1	49
G/H Element	2	4
Indicator	8	16
Gate Driver	4	8
Gate Terminator	3	5
One Shot	1	3
Compl. Driver	3	2
Cable Driver	4	5
NOR	5	107
Pallet boards, device simulator boards, miscellaneous boards, etc.		≈40

The first step of circuit checking will use a device simulator to check Pallet Boards, Word Buffers, Character Counter and Interplay Channel Control in communicating with main frame.

(L. Byers, H. Lopeman, R. Miller, R. Willard, Y. Yen)

6. IBM 1414 Interplay Channel Design

IBM 1414 Interplay Channel design and layout are completed on approximately half of the racks for this channel. The 1414 logic is currently under study to allow the full capability of the 1414 to be used in the NIC system.

(M. Pisterzi, R. Willard)

7. Core Memory

New regulators have been installed to supply +65 and -25 volts. Separate control for sense and xy sections are provided. The center tap of the "-50" mag-amp was used to feed the -25 volt regulators.

(R. Kingsley, L. Byers)

A continuing effort has been pressed to locate and correct the conditions in the core memory which cause errors. Alterations in certain power

distribution buses will be made as soon as the necessary parts are available. Meanwhile, the effects of read driver tolerance on error rate are being investigated.

8. Second Core Memory

The contract for this memory was awarded to General Ceramics Corporation this month (about the 15th). Delivery is quoted as eight months ARO, i.e., December 15.

The company was visited briefly on April 17.

(S. R. Ray)

9. Engineering Programming

During the month of April, two full-scale programs were written for the IBM 1401. One program tests the operation of four on-line tape units reading from two and writing on the other two. When full, all units rewind and the mode of each is reversed. Full power error checking is employed and running comments on the status of each unit are printed.

The second program written was a ditto-master-simulator program for program writeups using SPS-2 assembled programs. Various options are available including title page, page ejection and counting, SPS-2 Postlisting, section heading and others. When the master printout is made, a copy if formed on tape which is subsequently reproduced as many times as desired. The program may also be used to generate multilith masters.

Also completed during April were the final writeup of Engineering Test of Normalize and a new Delayed Control MAU engineering test called Division Addition Multiplication and Normalization which will be released during May.

An installation program test for Special Register 24 of the Interplay 1401 Channel was completed with programs for both the IBM 1401 and ILLIAC II.

Preliminary studies were begun on laying the groundwork for an Engineering Testing Monitor to be used during Main Monitor idle time.

(J. Bouknight)

10. Advanced Control Decode of Illegal Orders

Modifications to the Advanced Control order decoder are being made to enable classifying illegal orders as either a) meaningless or b) protected, i.e., not available to the normal user. The protected set of orders is being expanded to include Special Register orders.

(R. R. Shively)

PART II

ILLIAC II SYSTEMS PROGRAMMING AND OPERATION

This word is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Systems Programs

File No. 531 describing the address field optimization has been written and distributed. Planning has started on an Algol interpreter.

(C. W. Gear, N. Hamilton)

A routine to solve equations implied by the use of EQU pseudo orders, to be used in connection with pass II of the assembler, has been completed and checked out.

(Frank Schaffer)

Pass III of the assembler has been completed by the addition of routines for printing the source and the assembled program with error indications; it still has to be checked out.

(J. Nievergelt)

In preparation for the assemblers, input/output subroutine and interrupt program features of the drum and magnetic tapes were examined. Various programming techniques were considered and tested. Special attention is being given to drum transfers in order to obtain maximum efficiency. The programs are now in the flow-chart stage.

In consultation with the logic designers some features of the special registers were established.

(J. Aaron)

2. Library Programs

Code checking of the polynomial root subroutine has been completed. It is presently being changed to meet the conventions of a library subroutine.

The planning of a subroutine to find the inverse Laplace transformation of a rational function has begun.

(E. Brower)

3. Computer Use

Engineering Routines		
ETR	23:57	
Duplex Memory	4:03	
OLF	2:54	
Memory Reversing	4:22	
Cross Talk	3:50	
Total		39:06
Engineering		199:44
Code Checks		60:18
Production		
Mersenne Primes		266:35
FJ-17 (Fosdick Jordan) See Monthly Report, December, 1962		108:40
Demonstrations		:22
Idle or OFF		45:15
TOTAL		702:00

ERROR ANALYSIS

Reader	3
Punch	3
Core Parity	17
Power Dropout	6
Unknown	2
TOTAL	31

BAD COMPONENTS

Solder Joints		2
Fuses Blown		2
Wiring Errors		1
Variac (Reader Circuit)		1
Resistors		2
Stabistors		1
*Transistors		
Group 1	9	
Group 2	12	
Group 3	13	
Total		34
TOTAL		45

*Group 1--Perhaps spontaneous
Group 2--Induced by human error
Group 3--Questionable, removed as a precaution

(Majority of transistor failures are occurring in power supplies and memory drivers.)

(W. L. Huffman)

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

During April Henry Guckel re-examined the T-line and discovered that the propagation of surface waves caused considerable discrepancies between theory (based on a pure TEM mode) and practice. He has now converted his system to use broadside coupled strip lines.

Louis van Biljon has put a large amount of effort on both the theory and the experimental aspects of avalanching. Theory is complicated by the fact that for high collector voltages the depletion layer extends deeply into the base, thus increasing the gradient of hole density and the flow of holes across the emitter junction. At the same time the electrons generated in the depletion layer during multiplication modify all lifetimes. Methods are being considered to separate these two effects.

Sergio Ribeiro has finished his work on the phase-plane analysis of flipflops and has turned in a final report which constitutes also his Ph.D. thesis. G. Ujhelyi is working on laser theory and T. Burnside has made some progress with the statistical analyzer.

2. Transmission Line Amplifier

Evaluation of amplifier experiments with the T-line resulted in the conclusion that coupling and line impedances are approximated in the theoretical analysis in such a way that a 25 per cent deviation from actual values is possible. The reason for this is found in a) the propagation of a surface wave rather than a true TEM mode and b) the neglect of fringing capacitances.

The existence of the surface mode was checked experimentally by enclosing the T-line in a Rexolite casing made from two machined 3/4" x 3/4" x 18" blocks. The effects were apparently small. The experiment will be repeated after the fringing fields have been accounted for. The fringing fields are currently being studied theoretically. It is felt that a solution can be obtained for the geometry in Figure 1.

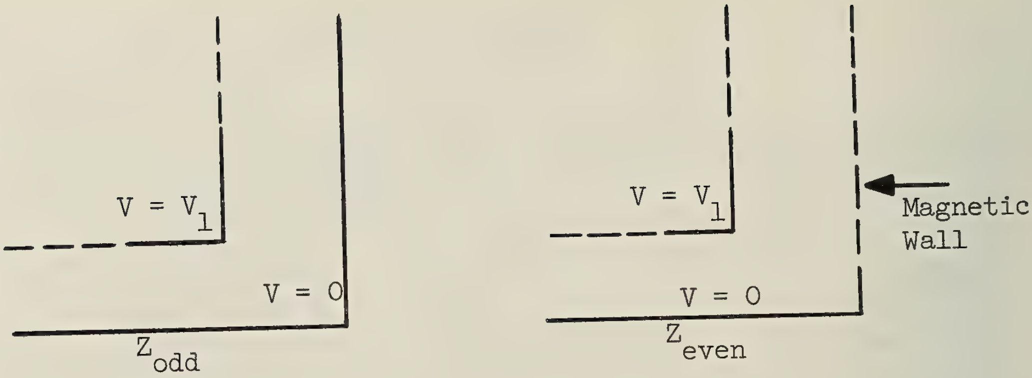

Figure 1. Transmission Line Modes

These configurations result if a) the two transmission lines are excited with V_1 and $-V_1$, and b) with V_1 and V_1 respectively. The relationships to the previously defined Z_o and Z_m are given by:

$$Z_o = \frac{1}{2}(Z_{odd} + Z_{even})$$

$$Z_m = \frac{1}{2}(Z_{even} - Z_{odd})$$

Since the T-line is still somewhat difficult to handle, the broadside coupled strip line[1] was re-examined. Such a line is shown in Figure 2.

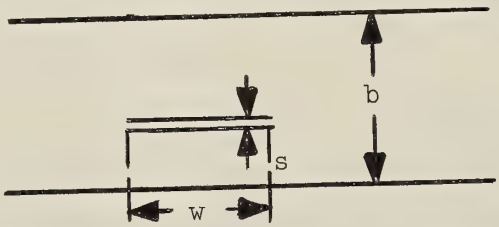

Figure 2. Broadside Coupled Strip Line

If w/s > .35 the following approximate formulas hold:

$$Z_{odd} = \frac{296.1}{\frac{b}{s}\sqrt{\epsilon r}\;\tau h^{-1}k}$$

[1] S. B. Cohn, "Characteristic Impedances of Broadside Coupled Strip Transmission Lines," MTT-8, Nov. 1960; pp. 633-637.

$$Z_{even} = \frac{188.3\ K(k)}{K(k')}$$

where

$$K(k) = \int_0^{\frac{\pi}{2}} \frac{d\phi}{\sqrt{1 - k^2 \sin^2\phi}}$$

and

$$k'^2 = 1 - k^2$$

The value of k is specified by

$$\frac{w}{b} = \frac{2}{\pi}\left[\tau h^{-1}\sqrt{\frac{\frac{b}{s}\,k - 1}{\frac{b}{s}\,\frac{1}{k} - 1}} - \frac{s}{b}\,\tau h^{-1}\left(\frac{1}{k}\sqrt{\frac{\frac{b}{s}\,k - 1}{\frac{b}{s}\,\frac{1}{k} - 1}}\right)\right]$$

The value of b/s is fixed by the available board thicknesses. This means that a constraint exists, i.e., Z_o and Z_m cannot be specified independently for a fixed negative resistor. The above formulas were programmed on the 7090 and evaluated for a series of values of k with b/s = 5. The results are very good.

For a desired Z_0 of 30 ohms the coupling ration Z_m/Z_o is given by 0.605. If b = 5/32" the value of w is 0.216". This is a reasonable geometry. Since the line is self-shielding and located entirely in a homogeneous medium, radiation loss will be lower and TEM propagation can be assured. Experiments involving this line are in progress.

3. Avalanche Effect

A circuit for the accurate measurement of the transistor I-V curves is practically complete and preliminary measurement have been made.

The circuit being used is as shown in the March progress report with a slight modification in the base circuit to allow I_B to be measured while α is still smaller than unity. The base circuit thus is as shown in Figure 3.

While the applied voltage is still so small that α is less than one switch S_1 is in position A. As α becomes bigger than one, I_B changes direction and S_1 must be at B for balance to be obtained.

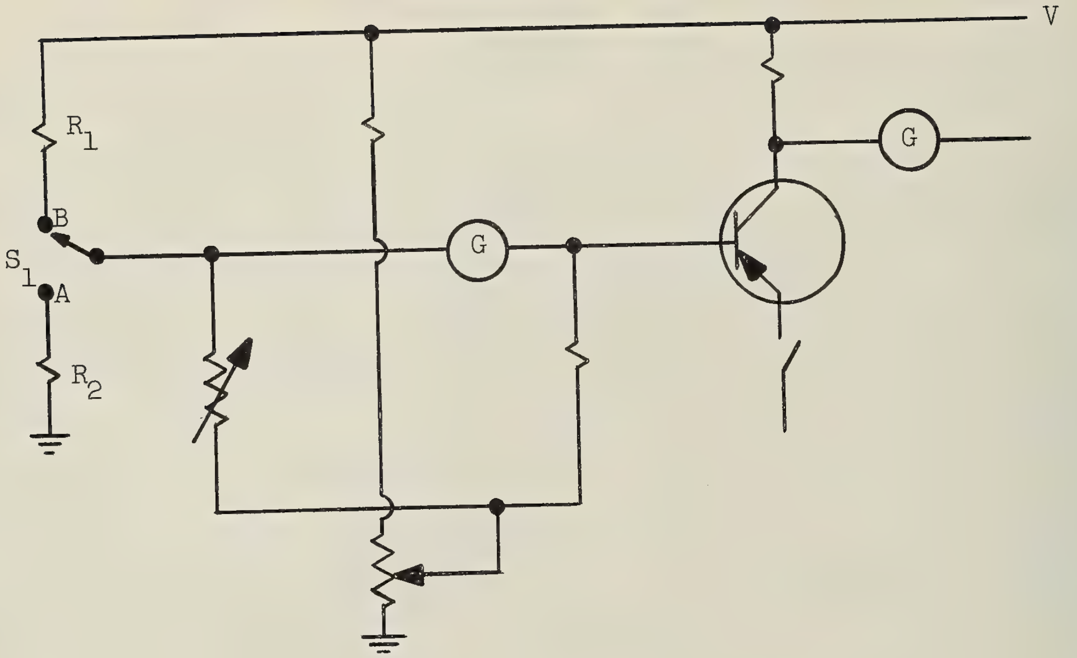

Figure 3. Base Circuit Test

In Figure 4 some preliminary measurement results on a pnp transistor are shown and the influence of dissipation in the collector on the saturation current between base and collector can be seen. The lower curve was obtained at the same pulse repetition frequency as the upper one, but the lower curve

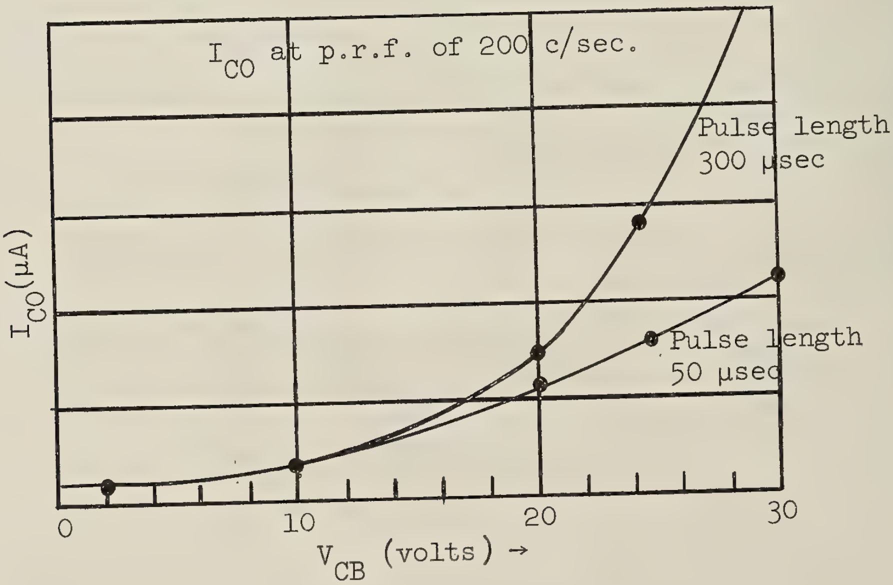

Figure 4. Influence of Pulse Width

had a pulse length of 50 μsec, and the upper one one of 300 μsec. Since the multiplication factor, M, is normally determined from the expression

$$I_{CO}(V) = M \cdot I_{CO}\Big|_{V=0}$$

The curves in Figure 4 illustrate that M is not immediately related to observed values of I_{CO}.

Calculations are also being made to establish to what extent the increased majority carrier concentration in the base region influences the alpha of the transistor.

The transport factor has been calculated for various sets of boundary conditions. Calculations are now being carried out in order to determine numerically how strong the various influences might be. The first parameters to be investigated is that of life time of minority carriers in the base. No results are yet available.

Negotiations are under way to obtain transistors of simple geometry and known physical characteristics to use in this investigation.

PART IV

MATHEMATICAL METHODS

(Supported in part by the National Science Foundation under grant G16489.)

Monte Carlo Methods in Quantum Statistics

1. A new technique for evaluating conditional Wiener integrals is being studied. This technique is an extension of the method described in a recent paper by L. D. Fosdick (Journal of Mathematical Physics 3, 1251 (1962)). The improved technique provides a systematic scheme for getting approximation formulas with an error that is of the order $(\Delta t)^p$ for any p, where Δt is the "time" parameter of the Wiener path. Although the techniques for developing these formulas are now understood their practical value is not yet clear, for as p increases the formulas become rather complicated.

2. A program known as FJ-18, which is an improved version of FJ-17 (see February Technical Progress Report) was written. The improvement consists in exact evaluation of the integral

$$\int V dt = \int_0^1 \left[\frac{1}{r^{12}(t)} - \frac{1}{r^6(t)}\right] dt$$

rather than an approximate evaluation by the trapezoidal rule as was done in FJ-17. (This is completely different from the "improvement" discussed in paragraph 1.) We have found that this new program does not substantially improve the accuracy of the Wiener integral calculation (see December Technical Progress Report). The reason for the small difference between the results generated by the two programs is not fully understood.

3. Using FJ-17 and the formula given by Brush (S. G. Brush, Proc. Roy. Soc. 242A, 544 (1957)) we have solved the implicit equation for T:

$$AT = \ln(5 - \xi)$$

where A is a constant chosen to represent He_4. Brush found two roots in the equation, one near T = 2°K and one near 3°K. We have found only the root near 3°K. Since our method for calculating ξ should be much more accurate than

Brush's, it appears that the root he found at $2^{\circ}K$ was a spurious result of his approximation. The root of the above equation should be, according to Brush (originally to Kihuchi), identified as a phase transition in He_4. Our result agrees closely with the observed λ-point in He_4, located at $\approx 2.8^{\circ}K$. However, the root of the equation is rather insensitive to errors in ξ and so the close agreement is not startling.

PART V

DATA REDUCTION METHODS

(Supported in part by Contract No. AT(11-1)-1018 of the Atomic Energy Commission)

1. <u>The Pattern Articulation Unit (PAU)</u>

The Pattern Articulation Unit (PAU), an all-digital processor for visual information, is presently under construction at the Digital Computer Laboratory. This unit employs a two-dimensional iterative array of 1024 (32 x 32) identical processing modules locally connected to execute boolean functions, threshold logic, and signal path building.

The custom-designed computer racks to house the array are in place, complete with connectors and power bussing. The indicator lamp display, one lamp for each module of the array plus border (or 1600 in total), has been installed in the console and wiring to the array is now largely complete. Indicator driver printed circuit boards are currently under construction.

The power distribution system has been redesigned to use silicon power transistors. System voltage are +12, +6 and -6 volts. Each regulator module provides 7 amps for the array. 300 such boxes are now under construction. (These are also used elsewhere in the computer.)

Each processing module of the array contains 43 silicon transistors and 210 silicon diodes. This circuitry is packaged on the 5" x 5" printed circuit board. Discrete fabrication of semiconductor components is used but film packaging of passive elements is now planned. Final specifications for the circuit components are currently under preparation--representing the third round with possible manufacturers. Wiring of the iterative array will be initiated this month. 40,000 taper pin wires have been prepared for this purpose.

A prototype of the ferrite core transfer memory (word size: 1024 bits) is under construction. This prototype represents approximately 25 per cent of the ultimate memory. An order for micro-circuit packaging for 32 of an ultimate 1024 sense amplifiers has been placed. The core stack of the prototype is now in house.

2. Fast Logic and Logical Design of the Other Processors of the Computer

In the ultimate computer the pattern articulation circuit (PAU) will be supplemented by three other basic processing units: to provide floating-point arithmetic, I/O, and list processing facilities. A fast register organization (actually a small 16-word associative memory) to buffer words between the memory banks and the working registers of the four processors is being mapped out. Multi-programming, up to one program segment per processor, will be allowed. The design stresses symmetry, not hardware minimization, of the over-all computer.

Custom-designed racks to house the logic of these three additional processors is either currently in place or on order. Allowance for 72 per cent of the arrowhead count of the STRETCH computer is being provided. Saturating diode-transistor logic (on a 44 pin printed circuit board) is being employed. Accordingly only four wings (approximately 3,200 boards total) are required. Actual logical design of the above three processors is still in its infancy.

Design of the diode, zener level-shifted, transistor saturating circuitry of this part of the computer is well advanced. Silicon semiconductor components are used throughout. Sixteen basic printed circuit boards have been laid out. Test evaluation with the TI microdiode 1N255 and the 2N744 give rise, propagation delay, and fall times per gate of approximately 10 nsecs/stage.

Design of a test console is now complete; fabrication is just being initiated. The central measuring element of the test console is a Techtronics digital readout oscilloscope. The test console facilitates dc and ac evaluation of sample populations of transistors, diodes, or printed circuit boards <u>under program control</u>: that is, the test console will be run on line to ILLIAC II and should yield ten tests per second.

3. Scanning Units

Three scanning units, respectively for bubble-chamber film, spark-chamber negatives and microscope slides, are under construction. Racks, digital control and high resolution CRT circuitry have been made interchangeable insofar as possible. In particular all three units use a 70" long x 68" high x 30" deep rack, custom-designed around a concrete-based "vibration-free" support for the cathode ray tubes, associated optics, and film (or slide) drive assembly. Initial orders for power supplies, tubes, focus coils, etc., have been placed.

The bubble-chamber negative scanning unit will employ vacuum clamping of the film to a slowly rotating capstan. Accordingly longitudinal digitizing of the film will be derived from a 16-bit angular digitizer. Transverse scan (or measure) of the film will be generated from a line sweep on the scanning (measuring) CRT.

The spark chamber film scanner employs sprocketed 35 mm film. The 23 mm x 26 mm film image is scanned driving the CRT in a digitally-generated TV-like scan. Two Flight Research cameras, redesigned for scanning purposes, are available for this purpose. The scanner, when complete, will contain two CRT assemblies, one each for each camera/scanner. Direct single lens optics is employed.

The film microscope slide scanner employs a precision stage on loan from the Lawrence Radiation Laboratory, Moiŕe fring digitizing, and subassemblies from a Zeiss photomicroscope (previously purchased). Target for positional control of the stage is $\pm$ 2.5 microns. This third scanning unit is being constructed leisurely, without high priority.

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S. Yamada

PART VI

IBM 7090-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

NEW ROUTINES

L1-UØI-SCRE-19-BX

SCATRE Scat-Compatible Assembler, Translator, Relocatable for the IBM 7090. In order to gain flexibility, it is desired that an operating system such as PORTHOS (The University of Illinois operating system) provide for the assembly of both absolute and relocatable programs. SCAT provides the former facility; this routine (SCATRE) provides the latter. Every attempt has been made to make the input language to both assemblers and their available operations consistent and similar.

A detailed description of the assembler is available in Room 165 Engineering Research Laboratory.

This routine is a revision of UMAP, the University of Michigan Assembly Routine.

(Wm. A. Wulf)

ØO-UØI-S650-25-BX

IBM 650 Simulator on 7090-1401 System (SIM650). This routine allows the running of IBM 650 programs on the 7090 without translation into 7090 code. The 650 is simulated exactly.

This routine is part of the "PORTHOS" monitor system and any program to be used with SIM650 must conform to the system requirements. For a detailed description of SIM650 see the detailed description which is available. For further details pertaining to the system requirements see the "PORTHOS" manual.

(Freda Fischer)

F2-UØI-EIG1-29-FR

Floating Point Eigenvalues and Eigenvectors of a Symmetric Matrix. EIG1, using non-iterative methods of Householder[1], Ortega[2], and Wilkenson[3], solves for the eigenvalues and corresponding eigenvectors of a real symmetric matrix. This program was written in FØRTRAN.

EIG1 has all input, output, and working storage listed in the calling sequence. No tapes are needed and previous allocation of COMMON storage is not disburbed. There is no reading, printing, or punching.

This program was obtained from the University of California, Berkeley Computer Center.

Programming: Davis W. Matula - April, 1962

Methods and Specifications: William Meredith
Computer Center and Department of Psychology (Project CAP)
University of California, Berkeley, California

(D. Hutchinson)

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[1] J. H Wilkinson, Householder's method for the solution of the Algebraic eigenproblem. Computer J., 3, April, 1960, 23-27.

[2] J. M. Ortega, On Sturm sequences for tri-diagonal matrices. J. Assn. Computing Mchy., 7, July, 1960, 260-263.

[3] J. H. Wilkinson, The calculation of eigenvectors of codiagonal matrices. Computer J., 1, July, 1958, 90-96.

D1-UØI-SIM1-30-FR

Integration by Simpson's 3 Point Rule. This routine uses Simpson's 3 point rule to approximate the definite integral $G = \int_{X_0}^{X_f} F(x)dx$. The error in the approximation is determined by a relative difference that the user supplies in the calling sequence.

Originally programmed for Control Data 1604 FØRTRAN by Gene Gilbert, University of California, San Diego, October 26, 1962.

(D. Hutchinson)

During the month of April, 57 new problem specifications were submitted for the IBM 7090

321-33056 Mechanical Engineering. Laminar Jet-Mixing of Compressible Fluids. In the study of heat transfer across separated flow regions, the finite wake flow velocity (φ_b) cannot be disregarded. Thereby, previous calculations on the velocity distribution within the laminar jet-mixing regions have to be modified.

The present intention is to set up a program to calculate the velocity distribution within such a jet-mixing region for various values of φ_b , so that the results may be readily employed to study the heat transfer phenomena across the separated flow regions.

The solution φ (f) will be obtained by solving a integral equation with iterative procedures. The integral relations are given as follows:

$$\varphi\ (f) = (1 - \varphi_b)\ \frac{\int_{-\infty}^{f} \frac{F(f)}{\varphi(f)} d f}{\int_{-\infty}^{\infty} \frac{F\ (f)}{\varphi\ (f)} d f} + \varphi_b$$

where

$$F\ (f) = e^{-\int_0^{f} \frac{f}{2\varphi(f)} d f}$$

It is expected that the final results may be obtained in four or five iterations.

322-33058 Psychology. Hypnotic Susceptibility in Children. This project is a long-term standardization of a test. The details of the complete procedure to be followed are not known at this time, as each step depends upon the results of preceding steps. At a minimum, it will involve factor analytic and associated routines, plotting routines, analysis of variance routines, and correlation routines.

323-33059 Astronomy. Coma Aberration. The purpose of the research problem is to relate the aberration of non-paraxial light incident upon a parabolic reflecting surface to the angle of incidence, point of incidence, and plane of orientation. The results will be determined in relation to the point of intersection of the reflected light upon a plane surface (photographic plate) located in the focal plane of the mirror.

The function of the computer in this problem will be to tabulate the abscissas and ordinates of intersection points on the photographic plate for points of reflection at various intervals around the mirror surface. From the tabulated data, graphs of the aberration at various paraxial angles may be plotted and analyzed graphically. Furthermore, the tabulated values will be compared with values obtained using various small-angle approximations and simplifications in order to test the validity of these approximations for this particular type of analysis.

324-33060 Aeronautical and Astronautical Engineering. Detonation Initiation. The problem involves the solution of one dimensional unsteady flow equations with heat addition using a finite difference technique. Machine use is necessary because the investigation will involve changing variables from problem to problem and hand calculation of each problem would be prohibitive. No special library routines will be necessary.

325-33061 Civil Engineering. Soil Classification and Statistical Analysis. One phase of this research project, Soil Exploration and Mapping, is to obtain physical properties of various surficial soils through sampling and testing. Each soil sample is classified according to the unified and AASHO systems on the basis of test results. Then, simple statistics, such as mean, standard deriation, coefficient of variation, standard error, and limit of accuracy, are determined on the similar soil types. This program will classify the soil and obtain the basic statistics mentioned above.

326-33062 Physics. T-Matrix. A simple relationship has been suggested for the dependence of the scattering T-matrix on its three momenta in the kinematic situations usually called "off the energy shell." A numerical study to substantiate this relationship (originally based on approximate analytical arguments) was stated last year using the IBM 650 computer. A more recent interest in repulsive potentials, not considered in the earlier work prompts a repetition and extension of the earlier work.

The t-matrix for scattering by a potential proportional to v(r) involves the integral

$$\int_0^\infty \sin k_o r \;\; v(r)\, U_{k,\, k_1}(r)\, dr$$

where U_{k, k_1} is a solution, with the boundary condition $U(0) = 0$, of

$$U'' + \left[k^2 - v(r)\right] U = \frac{k}{k_1} (k^2 - k_1^{\ 2}) \sin k_1 r$$

The parameters k, k_o, k_1 are the momenta associated with the Green's function of the problem, the outgoing wave, and the incoming wave respectively. The potential $U(r)$ will be any of the various two or three parameter shapes commonly used in nucleon-nucleon scattering studies.

327-34002T Chemistry and Chemical Engineering. Maximization of Overlap. Carbon-13-proton coupling constants in Nuclear Magnetic Resonance indicate anomalous second-order hybridization at the trigonal carbon atom of some substituted carbonyl compounds. Using known bond lengths and Slater-type orbitals, the total bond energy, proportional to the bond overlap integrals, can be expressed as a function of the hybridization of the carbon atom. This bond energy is maximized with respect to the two hybridization parameters necessary to describe the bonding. The relative magnitudes of these parameters in different molecules will then give an indication of the amount of second-order hybridization in the molecules relative to one another.

328-34003 Civil Engineering. Interaction of Plane Elastic Waves with a Cylindrical Cavity. Stresses in the vicinity of a long cylindrical cavity in an elastic medium when the cavity is enveloped by a plane stress wave will be calculated from a Fourier Series. A stress wave with unknown functions is assumed in the cavity to satisfy the conditions on the boundary of the cavity. Using these conditions unknown functions will be computed by using the Duhamel integral. Finally stresses and displacements described in terms of unknown functions will be computed.

329-34004 Mechanical Engineering. Multiple Species Interdiffusion. A system of N gases interdiffusing in a constant velocity, rotationally symmetrical stream is to be studied. The Rayleigh assumptions concerning self-diffusion have been employed to permit the description of the system by N equations of self-diffusion. A further discretizing assumption has been employed to permit the consideration

of the loss of certain species at a reaction zone in the space, along with the concurrent generation of new species. Further, as the (N + 1)th term of the system, the thermal conduction from the reaction surface has been included. This program also includes variation of the rate coefficients, as well as thermal capacitance, as a function of temperature.

330-34006 Psychology. Physiology of Motivation. The study deals with the motivational component factors of a group of 136 freshmen. 36 motivational variables (objective measurements of 6 attitudes times 6 different tests) and 32 personality variables are gathered in a three hour group testing. In a two hour individual testing various physiological variables (EEG, Eye movements, EKG, Breathing, PGR, etc.) are obtained as indicators of interest strength in the same attitudes. The various questions of the study group around two main points: whether the motivational component factors arise also from raw scores and how the new physiological variables fit into the known picture.

The IBM 7090 is planned to calculate the means, the standard deviations and the reliability coefficients of the variables (in some cases of the single items). Then the variables would be inter-correlated by the Pearson product-moment correlation formula. Since the existing factor-analytic programs are limited in the number of variables at least two different factor analyses with different variables are planned. The communalities would be estimated, the number of factors extracted by the principal axis method and rotated by oblimax. After the analytical rotation, a visual rotation by Rotoplot is planned. Also the Procrustes Program of factor matching and the Dwyer extension method relating variables outside the factor analysis will be used.

331-34007 Psychology. Factor Analysis of Personality. The research is concerned with the following problems. Factor analysis of a Dutch translation of the High School Personality Questionnaire (H.S.P.Q.) Forms A and B will be factorized together with several criteria measures as age and school type. Separate analysis are requested for both sexes because of the differences in high-school types. The number of subjects in each analysis will be about 450, and the number of variables 30. The preferable methods of analysis are principal axis and/or centroid method. Rotation of factors will be done by oblimax and rotoplot.

A sub-problem here is the computation of discriminant functions for the several types of high schools. As there is no complete program available for this kind of analysis only the computation of the dispersion matrix and its inverse will be done by the IBM 7090.

Factor-analysis of observations (38 variables) H.S.P.Q. (14 variables) and objective tests (40 variables) for a group of 170 delinquent girls for the 3 media together and separately by the same methods as described above. Probably a second order factor analysis will be necessary in this case.

Factor analysis of several 16 P.F. factors measured once in a general way and two or three times in specific role situations for a group of 100 subjects. The problem is to find out if a role appears as factor in this analysis. The same procedures will be followed.

A re-analysis of available data on group behavior dimensions, separately for mean personality characteristics of the groups (32 variables), group structure variables (24) and group performance variables (40). The number of groups is 80. A second order analysis will be done to find the relation between the three sets of factors. Analysis is again the same as above.

332-34008 Medicine. Psychiatric Interview Study. The raw data for this study consists of 105 items of statements on which the following ratings have been obtained: affect rating on a 7-point scale, 17 judges' ratings of meaningfulness on a 7-point scale, rating of length of statements - 35 long, 35 medium, 35 short. In addition, there exists or should be obtained: a mean rating for all judges 1-17, a mean rating for psychoanalysts, judges 1-10, a mean rating for psychologists, judges 11-17.

The following analyses of these data will be made: intercorrelate the 21 ratings, using all 105 statements, (this will give one 20 x 21 matrix of r's, N = 105); using the same 21 ratings, intercorrelate the long, medium, and short statements separately, (this will give three 20 x 21 matrices of r's, N = 35 in each matrix); and intercorrelate all 105 items, using only the ratings of judges 1-17, (this will give a 104 x 105 correlation matrix, N = 17).

333-34009 Electrical Engineering. Random Walk in Two Dimensions. The problem is a study of the two dimensional random walk trajectories of particles with controlled transition statistics. The statistics are a function of the position of the particles in the two dimensional space and also of the relative position of the particles with respect to one another.

334-34010 Mechanical Engineering. Roller Chain Selection. Use of library routines and ordinary procedures will enable a great deal of data to be evaluated by machine. This data will allow proper selection of optimum roller chain characteristics for any set of physical requirements.

335-34013 Agronomy. Exponential Regression Models for Plant Responses. In order to explain plant responses to various stimuli, it is often useful to formulate a mathematical model to describe the response. In this problem an exponential regression model,

$$y = L + B \prod_i \exp (K_i X_i)$$

will be utilized to describe the relationship of plant responses in terms of yield measurements, y, to various stimuli, X_i, such as soil fertility, applications of fertilizer, and plant population and distribution.

An iterative least-squares procedure for estimation of the parameters L, B and K_i will be used. The method is a modification of the Gauss-Newton method of fitting non-linear regression functions.

A Fortran program has been written and is available for use for this problem.

336-34018 Animal Science. Nutritive Value of Proteins as Related to Amino Acid Composition. This research attempts to establish a definite relation of nutritive value of proteins to their amino acid compositions. The mathematical method is the method of least squares.

337-34015 Civil Engineering. Shell Analysis. The analysis of a saddle shaped hyperbolic paraboloid shell with variable edge members by second order finite differences equations will be undertaken. Approximately 65 simultaneous linear equations are to be solved using the standard library routine.

338-34016 Agronomy. Vertical Flow With Hysteresis. The problem involves the solving of the flow equation:

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial Z} \left(K\,(h,\, hr)\, \frac{\partial H}{\partial Z}\right)$$

where

Θ = water content

t = time

Z = depth increment

K = hydraulic conductivity

H = hydraulic head

hr = pressure head

for a column of soil that has been drained from saturation and then rewet from the top. The relationship will be a function of the pressure head, hr, at each level in the column at the time rewetting starts. Using finite difference methods, the approximate solution is reduced to the tridiagonal form:

$$\begin{bmatrix} 1 - J_1 & 1 & & \\ & 1 - J_2 & 1 & \\ & ---- & & \\ & ---- & & \\ & & & 1 - J_{N-1} \end{bmatrix} \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \vdots \\ \varphi_{N-1} \end{bmatrix} = \begin{bmatrix} -H - \varphi_o \\ -H_2 \\ \vdots \\ -H_{N-1} - \varphi_N \end{bmatrix}$$

where φ_o and φ_N are boundary values. The coefficients J and H will be computed from tables of input values. A special algorithm, derived from Gaussian elimination techniques, will be used to solve this system. A typical matrix size will be between 25 X 25 to 100 X 100. A particular run may have to evaluate as many as 200 points with respect to time.

339-34017T Communications. Cross-Cultural Congruity Study. This study is an attempt to investigate the sematric factor structures of Japanese, Finnish and American subjects, and to test the congruity phenomena operating in these semantic spaces.

First, analyses are carried out in order to find the factor structures of various semantic spaces, using a psychological measurement called a semantic differential. In these analyses, correlation, principal component factor analysis, and Varimax simple structure rotation schemes will be used.

Second analyses are a series of three way analysis of variance which is used to test the effect of a number of variables upon the occurrence of congruity phenomena.

340-34018 Digital Computer Laboratory. On Line Bubble Chamber Data Reduction Using the Scanning Measuring Projector. A bubble chamber data analysis system is being developed by the Digital Computer Laboratory and the Physics Department of the University of Illinois and the Lawrence Radiation Laboratory of the University of California. A Scanning and Measuring Projector is to be operated on-line to the 7090 with the operator of the projector scanning and measuring in accord with instructions from the computer program. The data supplied to the computer are to be checked and subsequent instructions issued to the operator based on the nature of the data. Eventually some form of complete analysis of the nuclear interaction will be incorporated in the computer program so that the operation can be instructed to remeasure the event if the data fail to lead to a satisfactory analysis.

341-34019T Education. Inquiry File. The Inquiry File is an attempt to develop a tab file as a more reliable substitute for the Inquiry Questest that is used in the Illinois Studies in Inquiry Training. The major features of both the file and the Questest are the provision of a free-response testing situation which allows the student to ask questions autonomously. An analysis of dispersion will be used to determine the comparability of these two methods. A number of different transformations on the original data must be performed, since it is known that the variances of scores under the two methods are not homogeneous.

342-34020T Psychology. Experimental Determination by P-Technique of Functional Unities of Depression and Other Psychological States. The original problem was to describe in terms of a small number of reference dimensions 80 variables related to manifestations of depression. The factor solution yielded 14 factors which were given 8 rotations. The problem now begins a second phase of rotations, since the structive obtained by the first rotations is not yet satisfactory. The standard library routine, rotoplot, will be used for about 10 additional rotations.

343-34021T Electrical Engineering. Doppler Shift Mixer. When an intense electric field accelerates the electrons in the bunched rebatron beam in a transverse direction, the electrons radiate at a frequency equal to the sum of the beam harmonic frequency and the accelerating field frequency. For a given set of parameters, the design should account for deflection of the beam as a function of the relative phase relation between the beam and the accelerating field,

frequency determination controlled by doppler shift equation, and interference of other than designed normal modes at nearby frequencies.

Since there are more than one set of parameters and the doppler shift equation is an implicit equation for the unknown, it is believed the computer can be best utilized for repetitive calculations of similar form and very suitable for the iterative method employed in the calculation.

344-34023T Chemistry and Chemical Engineering. Time-Space Correlations of Turbulence. Of particular interest in the study of fluid turbulence are the measurements of time-spatial correlation coefficients. Using digitized data derived from sampling the analog voltage drop across a resistor acted upon by the limiting current from an electro-chemical reaction, it is proposed to compute auto-correlation, spatial correlation, and space-time correlation coefficients from signals arising out of two spatially separated electrodes.

The general space-time correlation coefficient, $R_{\tau, \Delta x}$ is defined by

$$R_{\tau, \Delta x} = \lim_{T \to \infty} \int_0^T S_1 (x,t)\, S_2 (x + \Delta x,\ t + \tau)\, dt$$

where t is time, S_1 and S_2 are the signals, x is the spatial coordinant, and τ is the time displacement. This expression can be simplified to yield the simple spatial correlation coefficient by making τ equal to 0, or the auto-correlation coefficient by making Δx equal to 0. For such a system the spectral density function W is given by the Fourier transform of the auto-correlation function. Symbolically this is expressed by

$$W = \frac{1}{2\pi} \int_{-\infty}^{\infty} e^{-iw\tau} R_{\tau, o} \quad d\tau$$

where w is the frequency.

The method of solution for the quantities mentioned above is rather straight forward. The analog signals would be digitized and using this data integrands would be calculated and the integration approximated by the Trapezoidal Rule.

345-34024 Chemistry and Chemical Engineering. Chemical Kinetics. The problem

is to solve the following system of standard reaction equations for the concentrations C_j ty the Runge-Kutta Gill method for fixed ΔT

$$\frac{dC_j}{dt} = \sum_{i=1}^{n} K_i a_{ij} \prod_{\ell=1}^{m} c_\ell^{\nu_{i\ell}}$$

From this will be obtained:

$$X_i(T) = K_i \int_0^T \prod_{l=1}^{m} \left[C_j(\theta)\right]^{\nu_{i\ell}} d\theta \text{ by Simpson Rule}$$

$$D_j(T) = C_j(T) + \sum_{i=1}^{n} a_{ij} x_i(T)$$

The following end tests must be met before the program stops:

1) $T > r_o \Delta T$
2) $\left|\frac{dC_j}{dt}\right| \leq 10^{-S_j} \quad j = 1, 2, \ldots, m$

or $T = r_f \Delta T$, whichever comes first.

346-34012 Psychology. Generalized Learning Curves: Paired Associates Learning I. This project is an experiment in the application of a development on determination of generalized learning curves by factor analysis. In particular, the experiment involves learning of paired associate nonsense syllables. The 7090 will be used to pre-multiply the data matrix by its transpose, determine the characteristic roots and vectors of the product matrix, and perform transformations by matrix multiplication on the results.

347-34025 Bureau of Community Planning. St. Louis Industrial Space Study. This study deals with the analysis of space used in various categories of use-type by a sample of industrial firms in the St. Louis, Missouri, Standard Metropolitain Area. The data to be analysed are of three types; dichotomous variables relating to the Standard Industrial Classification of the firms, percentage space-use for various use-types, and amount, in square feet, of space-use per employee for various use-types and types of employees. It is the objective of this phase of the analysis to ascertain which of the variables account for most of the inter-firm differences in space-use and what groupings occur of firms with similar space usages but different products.

These objectives can be facilitated by subjecting the data to factor analysis both with and without the dichotomous variables. The complete matrix to be employed has 18 variables for 72 firms. The partial matrix without the dichotomous data has 12 variables for 72 firms.

The study is designed to provide insight into industrial space use which should be of value to planners and to industrialists.

348-34027T Civil Engineering. Synthetic Hydrology and Simulation. The purpose of this problem is to evaluate the statistical characteristics of annual floods in a basin by use of Monte Carlo methods and subsequent simulation of the system. Use will be made of the 7090 to carry out a determination of the weighted average rainfall over the basin for all storms using the equation,

$$I_{i,j} = \frac{1}{A} \sum_{k=1}^{m} I_{i,j,k} A_k \quad \text{where}$$

$I_{i,j,k}$ = Rainfall in year i at time period j in station k;

$I_{i,j}$ = Weighted average rainfall in year i at time period j;

A_k = Area corresponding to station k; and A = Total basin area.

A statistical model for time distribution of rainfall in an annual storm of the following form is used:

$$I_{i,j} = A_j I_{i,j-1} + B_j \left(\sum_{r=1}^{j-2} I_{i,r} \right) + \epsilon_{i,j}$$ where A_j and B_j are coefficients of multiple linear regression and $\epsilon_{i,j}$ is the random component. A_j and B_j are determined using least square multiple linear regression at 5% significance level. The mean, variance and distribution of ϵ_j for j = 1, ------, n., are determined. Goodness of fit test is used for the distribution.

Total abstraction up to period j = total rainfall up to period j -(Total runoff up to period j + water available in storage at time period j). Stated mathematically

$$\sum_{j=1}^{k} L_{i,j} = \sum_{j=1}^{k} I_{i,j} - \sum_{j=1}^{k} Q_{i,j} - S_{i,j} \qquad \text{when} \quad \sum_{j=1}^{k} L_{i,j} \geq \sum_{j=1}^{k-1} L_{i,j}$$

$$= \sum_{j=1}^{k-1} L_{i,j} \qquad \text{otherwise}$$

For each storm and for all $j=1,----,n$, $L_{i,j}$'s are evaluated. Knowing Δt, f_c and K in the abstraction equation

$$f_{i,j} = f_c + (f_{i0} - f_c)\, e^{-K(j-1/2)\Delta t}$$

the initial abstraction capacity f_{i0} in each storm is calculated and its distribution determined.

Assuming a system function of the form

$$h(t) = \frac{1}{c\,\Gamma(n)}\, e^{-t/c} \left(\frac{t}{c}\right)^{n-1}$$

for the linear basin system, n and c are evaluated for each storm using method of moments. They are then correlated with storm parameters.

By the Monte Carlo method 1000 synthetic storms are developed. Also the corresponding initial abstraction capacity and the resultant rainfall excess distribution during each storm are determined. The synthetic storms are routed through the system and the corresponding annual floods are derived. The 1000 synthetic floods are analysed for the statistical characteristics of annual peaks, the duration that a given discharge is exceeded during annual floods, etc. The results from this study are compared with those from conventional statistical analysis when available.

349-34028 Institute of Government and Public Affairs. Determinants of Governmental Expenditure. Multiple correlation analysis will be used to determine the degree of association among several demographic, income and socio-political variables and per capita state and local government expenditure of the fifty states. Twelve independent variables will be used in the first run, but it is expected that several of these will be dropped. Those to be dropped will be chosen on the basis of the size of the standardized regression coefficient and by considerations of theory, comparability with previous studies and availability of data for future use of the method.

Several reruns of the correlation analysis will be made to permit the decisions as to which variables will be dropped and to permit the computation of multiple-partial correlation coefficients.

The regression equations will be used to compute the "expected" expenditure of each state, in total and for each of the eleven functions for which data are available. The differences between "expected" and actual expenditure will then be the basis of further analysis, using non-quantitative methods.

350-34029 Agricultural Economics. Sector Model of Feed Livestock Economy. The problem is to estimate a sector model of the feed livestock economy, using least squares linear regressions.

The estimates derived will be used to appraise alternative public policy actions with respect to hog production and marketing.

351-34030 Economics. Economic Forcasting. The purpose is to check out and make operational the IBM program "Forecasting by Econometric Methods."

352-34031T Chemistry and Chemical Engineering. Vibrational Analysis. In order to interpret experimental kinetic isotope effects according to existing theories of chemical reaction rates, it is necessary to do a normal mode analysis of the reacting molecules and certain proposed "Reaction Complexes." This is a mathematical problem involving the solution of a secular equation of large order, often as great as 70 or larger. The eigenvalues and eigenvectors of such secular equations can be solved for by straight forward iterative numberical methods which are readily amenable to computer methods.

353-34034T Agronomy. Corn-Teosinte Crosses. The analysis of twelve populations derived from interspecific crosses involving Zea mays L. (maize) and Euchlaena mexicana Schrad. (teosinte) are contained in the problem. The chief objective of the study is to find out the genetic effect that certain strains of teosinte contribute to the genotypic variance in back-crosses to the maize parent. The analysis of variance is used to define the data for three vegetative and seven mature plant characters.

Linear or quadratic response for generations and meaningful comparisons for populations measure certain genetic effects. The interaction terms of the analysis detect any deviations from expected response for generations at certain population levels. The between family and within family variance analysis measures fluctuations that may occur within a generation and population.

354-34035 Psychology. Influence of Response set on California Personality Inventory. Personality questionnaires have a great deal of their variance explained by the response set of the subject answering them. This study attempts to compare the factorial structure of the 18 scales of the California Personality Inventory in four situations: original scores, scores corrected for acquiescence, scores corrected for social desirability, and scores corrected both for acquiescence and social desirability. To correct for social desirability, a first factor will be

placed colinear to that trait before proceeding with the usual procedures of factor analysis on the residual correlation matrices. Altogether, four different factor analysis will be made by the IBM 7090.

355-34036 Forestry. Characteristics of Small Woodland Owner Behavior. There are two stages to this problem. The extraction of second order factors from a matrix of first order factor intercorrelations will be carried out. The first order factors were based upon test scores and characteristics of small woodland owners in Illinois. Procedures will involve estimation of communalities, estimation of number of factors, principal axis factor analysis, varimax and oblimax rotation of factors, and rotoplot rotation of factors. Secondly, an estimation of correlations between variables as yet unanalysed and the primary factors will be made. This general procedure is known as Dwyer extension.

356-34037 Psychology. Cyclothymic Attributes. Clinical descriptions of normal cyclothymics refer to their having a character structure similar to manic-depressives Personality and genetically determined blood factors which have discriminated manic-depressives from normals are being used to compare normal cyclothymics and non-cyclothymics in an effort to determine whether the clinical hypotheses regarding similarities between manic-depressives and cyclothymics are borne out.

357-34040 Agricultural Economics. Country Elevator Study. The problem involves a study of the organizational and competitive aspects of country grain elevators and the effects of their income and expense items on operating profits and handling margins.

The method to be used is multiple linear regression.

358-34041T Psychology. Simulation of A Complex System. The problem considered here is the predictability of the behavior of a complex state-determined dynamic system despite a lack, from an observers point of view, of information sufficient to predict the system's behavior in detail. Sought are observable behavioral invariances over time which are shown by the system regardless of this lack. The system observed is a network of a large number of simple finite-state dynamic elements (sequential circuits). Of particular interest in this study is the effect on behavior of relaxing certain of the network's structural constraints (due regard is to be paid to the effect of different functional characteristics of the basic elements).

Given a system of such complexity as is examined here, a high-speed facility is needed to simulate the system, and a high-capacity facility is necessary for analyzing behaviors. The 7090 appears to be the method of choice for realizing the system and for recording and analyzing its behavior over time.

359-34042 Digital Computer Laboratory. Charge Transfer. The investigation aims at a description of charge transfer across the base of a transistor. The IBM 7090 will be used to determine the influence of variation in certain parameters on the charge transfer factor. Standard routines are used.

360-34043 Mechanical Engineering. Ejector Calculations. The complete calculation of the internal flow for ejectors requires extensive calculations in several aerodynamic regions. These calculations are of the step-by-step method and extremely tedious without the use of high speed computers. The completed program will allow the complete calculation of the entire ejection surface taking into account the choking of the secondary stream and functional effects along the shroud surface.

361-34044 Civil Engineering. Water Distribution Study. This study is concerned with the delineation of criteria for the expenditious design of water distribution systems with components comprising a pumped input, a distribution pipe network, and equalizing storage. The characteristics of the pipe network and storage capacity are expressible in equation form. The pump characteristic is not readily described by a simple equation and an equation of fit to control values will be developed with the computer. The system equations are both linear and non-linear. Varying levels of input must be reconciled with the system component characteristics, with iteration for each input step until all equations and boundary conditions are satisfied. Each input step is bounded by the conditions of the previous step so that a serial or sequential ordering must be preserved.

The system parameter values will be varied as well as the demand data. Because absolute numerical values will be handled, the proposed work is purely computational. Some computations have been performed by hand, in the past year, to define boundary conditions.

362-34045T Chemistry and Chemical Engineering. Boiling on Fin. The problem is to predict the temperature profile and temperature gradient along a fin while

boiling is taking place on the fin. The system is described by the equation

$$\frac{d^2T}{dx^2} = F(T)$$

where F(T) is an experimentally determined function and cannot be represented analytically. F(T) will be evaluated employing interpolation from a table of experimental values. The differential equation will be solved using a standard library subroutine.

363-34046 Mechanical Engineering. Solution of the American Society of Mechanical Engineers Standard Shaft Equation. The problem to be considered is one which can be represented in the form of a polynomial equation of the eighth order. The computer will be used to evaluate this equation.

Solutions obtained will give direct answers to shaft sizes used in gear drives.

364-34047T Chemistry and Chemical Engineering. Crystal Structure of $Al(AcAc)_3$ The accurate determination of the crystal structure of Aluminum (III) Acetylacetonate by three-dimensional methods is to be carried out as the first step towards a possible proof of the Jahn-Teller effect which is predicted in the ligand-field theory.

In the solution of the crystal structure of this compound, the usual crystallographic calculations are to be performed on the IBM 7090. These calculations are as follows: calculation of diffraction angles and interplanar spacings for all observable hkl values, calculation of Lorentz-Polarization corrections to be applied to observed intensity data, calculation of three-dimensional Patterson functions and electron densities by means of Fourier summations, calculation of structure factors, and refinement of atomic and thermal-motion parameters by means of least squares.

365-34048 Bureau of Educational Research. Reliability of Rectangular Case. It is desired to obtain the average value of the statistic

$$\frac{b^2}{(b^2 + e)}$$

as a function of several parameters. It is assumed, first, that b^2 is rectangularly distributed with range 2h and mean g, subject to the constraint $\overline{b} = 1$. The

conditional distribution of e given b^2 is rectangular with range 2n and mean

$$a(b^2 - \bar{b}^2) + \phi$$

The integral of the distribution is to be evaluated for approximately spaced values of the parameters.

This statistic is a fundamental one in psychological test theory. It is customary to use ϕ^{-1} as an approximation, and the present problem is to examine the error of approximation.

366-34049 Mechanical Engineering. Shaft Deflection. This program will calculate the reactions at the bearings of a shaft and then calculate the shaft deflection by means of the double integration method.

367-34050 State Water Survey. Raingage Interpretation. This program will interpret raingage readings which are obtained from a weighing bucket recording raingage. The chart from the raingage will first be read by a Benson-Lehner Recorder to obtain card information of the rainfall amounts at varying time values. The cards for 50 raingages, which comprise the East Central Illinois Raingage Network, will be submitted to the 7090 where 5 minute rainfall amounts from each gage and also 5 minute amounts for the entire network will be determined. During the pass the maximum rainfall rate at each gage will also be determined.

368-34051T Mechanical Engineering. Temperature Distribution in Solids. The problem to be investigated is the temperature distribution in a rectangular solid which has a variety of boundary conditions including that of thermal radiation. A second order partial differential equation will be solved using the method of finite differences. Only basic mathematical operations and standard library routines will be needed in this solution.

This analysis is for the purpose of investigating the temperature distribution within a rectangular solid using various parameters and combinations of boundary conditions in an attempt to find regions where a simplification of the more general formulation can be justified.

69-34052 Mechanical Engineering. Laminar Film Boiling. When a surface n contact with a fluid is at a sufficiently high temperature, film boiling ccurs. The partial differential equations governing the flow and heat transfer henomena of rotating film boiling have been reduced to two sets of ordinary on-linear differential equations. One set governs the flow and temperature ields in the vapor layer, the other set the same fields in the liquid layer.

Numerical solution of the equations will enable detailed study of the flow and temperature fields, provide important heat transfer and drag characteristics, and enable an evaluation of the influence of several significant parameters entering in the analysis on the heat transfer and drag.

Each set of ordinary differential equations is non-linear and of a form for which analytical solutions are not available. Hence, numerical methods must be utilized to obtain the solutions. Further complications arise because not all of the boundary conditions are given at the starting point of the integration. Thus the problem to be solved consists of determining solutions to two sets of coupled non-linear differential equations with some unknown conditions. The principles of the method of solution have been used in a simpler problem of the same type with success.

370-34053T Chemistry and Chemical Engineering. Complex Decay Resolution. The 7090 will be used to resolve complex radioactive decay curves of 2 and 3 components. Systems of equations as follows will be solved:

$$A(t_1)\,X + B\,(t_1)\,Y + C\,(t_1)\,Z = D\,(t_1)$$

$$A\,(t_2)\,X + B\,(t_2)\,Y + C\,(t_2)\,Z = D\,(t_2)$$

$$A\,(t_3)\,X + B\,(t_3)\,Y + C\,(t_3)\,Z = D\,(t_3)$$

for X, Y, + Z where $A\ (t),\ B\ (t), + C\ (t_3)$

$$= f\,(e^{-\lambda_1 t},\ e^{-\lambda_2 t},\ e^{-\lambda_3 t}).$$

The D (t) are the experimental data.

371-34054 Psychology. Studies of Negotiation. This research problem is an attempt to delineate the nature and dynamics of the negotiation process, and to identify factors which determine negotiation success. The research will include a number of studies of experimentally-created negotiation situations, which will simulate many features of actual negotiation situations. Data analyses will include intercorrelational analyses and factor analyses of batteries of individual and group measures; analyses of variance to test hypotheses about the effects of experimental conditions on negotion outcomes; and other standard statistical tests of significance of differences and degree of association between variables.

372-34055 Electrical Engineering. Randomly Spaced Antenna Arrays. Generation of a block of random numbers

$$x_1, x_2, \ldots x_n$$

whose distribution has density function

$$p(X_n) = \cos^2 \pi \frac{X_n}{2}, \quad |X_n| \leq 1$$
$$= 0 \qquad\qquad |X_n| > 1$$

will be carried out.

Using the above block of random numbers, sums of the type

$$P(n) = \frac{1}{N} \sum_{n=1}^{N} \cos nX_n$$

where $N \cong 500$ will be evaluated.

The number of different trials for which the sums $P(n)$ are to be evaluated will be determined later. An initial guess is about 10^4.

373-34056T Theoretical and Applied Mechanics. Large Deflections of A Beam Column. The post-buckling configuration of a beam-column can be determined by using the exact Bernoulli-Euler relation in the bending-moment equation. The member under consideration is an axially-loaded column supported at its ends by rotational springs and at its midpoint by a linear elastic spring. The resulting non-linear differential equation can be solved by expanding the terms in power series of the arc length of the beam. After truncating the series, two non-linear simultaneous equations in the two unknowns, the slope under the load and the deflection at the mid-point, are obtained. These equations can be solved on the IBM 7090 by the Newton-Raphson procedure.

374-34057 Civil Engineering. Free Field Ground Motions. Media of axially symmetric half spaces and spherical full spaces are discretized into masses, springs and shear elements on a grid network. A loading pattern is applied to the surface masses. The resulting accelerations are given by Newton's Law; the velocities and displacements are determined by a step-wise integration technique. The deformational characteristics of the media can be assigned to the discrete elements of the models. Problems of elastic and elastic-plastic materials will be solved. By repeated determinations of accelerations and displacements of the masses, and the stresses in the springs with increasing time intervals, the propagation of a stress wave is obtained.

The IBM 7090 is required to perform the iterative integrations and to calculate the stresses at each grid point during every integration time interval. Because of the many time intervals required in a wave propagation problem in a discretized system, the automatic digital computer is an indispensable tool for the study of the above problem.

The effects of discontinuities in the medium and the dependence of material parameters and integration time intervals on the computational procedure, including stability limits, are to be studied.

375-34058 Digital Computer Laboratory. Study of List Processing Techniques. A study of the application of list processing techniques on the 7090 will be done using a word frequency analysis program. Specific uses of lists in this program will be alphabetizing, starting of words read, and keeping track of word counts. Printing of the processed words will use the lists composed to speed up and facilitate the output of the computed answers.

The fundamentals of list processing were introduced to the user in Professor McCormicks Math 395 Advanced Programming Course, Spring, 1963. It was then desirable to further study them from the viewpoint of actual application.

376-34059 Institute for Research on Exceptional Children. Semantic Differential Factor Scores. Approximately 300 junior high school students responded to a semantic differential instrument consisting of 10 stimulus concepts and 14 bi-polar adjective pairs the responses to which constitute the "meaning" of each concept for the subject.

Previous research has indicated that the responses to the adjective pairs (the responses are on a 6 point scale) can be analyzed into n orthogonal factors where n is some number less than the number of adjective pairs used to elicit the meaning of the concept.

The purposes of the present analysis are (a) to obtain orthogonal factors and (b) to compute a set of factor scores for each subject's responses to each concept. The factor scores obtained will enable more efficient use of the data. The factor scores will later be used (along with other data) as partial input in subsequent analyses aimed at prediction of classroom performance of the subjects.

It is anticipated that the following routines will be required to process the raw data, routine to generate a matrix of Pearson product-moment

correlation coefficients, Principal Axis factor analytic routine, Varimax rotation routine to obtain orthogonal simple structure and matrix multiplication to obtain the factor scores.

377-34060 Social Work. Northeast Champaign Urban Renewal. This project was developed for the purpose of uncovering some of the attitudes of persons living in the North-East Champaign Urban Renewal Area. The sample was determined by the random sample method. Seven interviewers interviewed ten persons each. Standard statistical analyses of the responses are to be carried out.

During the month of April, seven problem specifications were submitted.

58-33057 Aeronautical and Astronautical Engineering 216. The machine will be used to calculate a flow field using the method of characteristics for steady two-dimensional supersonic flow. The results of this calculation will be passed out in class for further analysis by the class. Their analysis will not involve machine computation but will use only the results of the machine computation. In this way the class will see the effects of net size on the calculations accuracy and in addition will appreciate the power of machine methods when applied to aerodynamic calculations.

59-34005 Mechanical Engineering 409. The temperature field in a two or three dimensional conducting medium with internal heat generation will be solved by relaxation techniques. The program will be designed to accept a Semi-FORTRAN description of each particular field of concern.

60-34001 Mathematics 195. Problem 7. A data deck contains a number of cards with a floating point number, one per card, punched in columns 1-20. Columns 21-80 are to be ignored. Write a FORTRAN program which will read this data deck, print this data, count and print the number of cards, compute and print the mean and root mean square thus

$$\text{MEAN} = \frac{\sum_{i=1}^{N} A_i}{N}$$

$$\text{RMS} = \sqrt{\frac{\sum_{i=1}^{N} (A_i)^2}{N}}$$

where A_i is the floating point number punched on the $i^{\underline{th}}$ card and N is the number of cards.

61-34032 Physiology 491. The purpose of this research is to determine the differences in selected immediate physiological responses of young men related to changes in pace of interval running in respect to the following: interactions differences, and correlations between physiological variables and run speed, number of runs, and run time; and the relationship between maximal runs and

interval runs in respect to physiological responses to each.

The Fortran program will be used to analyze the following: speed, repetitions, run duration vs. oxygen intake, pulmonary ventilation, and heart rate at the start and end of 4 runs, 3 sets of 4 runs performed at different speeds; speed, repetitions, and run duration vs. oxygen intake, pulmonary ventilation, and heart rate at three points in time during recovery from each set of four runs; and the interrelationships between maximum runs and interval runs in respect to oxygen intake, pulmonary ventilation, and heart rate during running and recovery from running.

62-34033 Nuclear Engineering 490. Term papers have been assigned to each student in the course and several of the topics lend themselves to evaluation by digital techniques. Normally they will be of the nature of parametric studies of the analytical results from theory. The use of function sub-routines such as Bessel Functions, etc. is expected in most problems.

63-34038 Civil Engineering 391. Problem 3. The object of the problem is the analysis and design of a reinforced concrete beam, continuous over one support. Influence lines for the moment at evenly-spaced distances along the beam are constructed and used to compute the maximum moment over the support. The maximum moment is then used as a basis for the design of the beam.

64-34039 Mathematics 195. Problem 4. The students are to write a FORTRAN program using Newton's method to find the 10 smallest roots of

$$\text{Sin}\,\pi x^{3/2} = e^{-x} \quad \text{for } x > 0$$

and to print out "NO CONVERGENCE" if the number of iterations is too great or print out "SOLUTIONS OF TRANSCENDENTAL EQUATION"

"X YERROR XERROR ITERS."

with X the solution, YERROR the difference between the sine and exponential.

XERROR is the YERROR/$\left|\frac{d}{dx}(\sin \pi x^{3/2} - e^{-2})\right|$

ITERS is the number of iterations required for convergence.

Information on the utilization and reliability of the IBM 1401 and IBM 7090 for the month of April, 1963 is given in the tables below.

TABLE I - IBM 1401

Summary of Use

April, 1963

Scheduled Engineering	- 0 -
Unscheduled Engineering	36:31
Maintenance	2:50
7090 Preparation	348:13
Tape Labeling	:15
Deck Reproduction	:56
Listing	7:30
Code Checking	11:24
CDC Preparation	1:28
Monthly Report	3:36
Tape Copy	1:14
Tape Dump	2:39
Idle	11:33
	439:02

TABLE II - IBM 1401

Summary of Machine Errors

April, 1963

1401 Main Frame and Storage	24
1402 Reader	5
1403 Printer	6
729V Tape Units	2
	37

DATE	RUNNING OK TIME	UNSCHEDULED ENGINEERING	MAINTENANCE	IDLE	TOTAL RUNNING TIME	FAILURES	IBM 1401 DAILY TIME DISTRIBUTION
4/1/63	14:55	:55	:10		16:00	2	(1) 1403 Printer failed to print position No. 27. 3 residuals replaced. (2) Binary trouble. Binary cards being written on tape as BCD cards.
4/2/63	18:47		:10	1:33	20:30	1	(1) 7 punch in Col. No. 1 of Binary card is either not being read or interpreted correctly. It is written on tape as BCD image.
4/3/63	20:06		:10		20:16	1	(1) Binary trouble continues
4/4/63	20:15		:30	:05	20:50	1	(1) Binary trouble continues
4/5/63	18:45		:10	:55	19:50	1	(1) Binary trouble continues
4/6/63	3:37				3:37	1	(1) Binary trouble continues
4/8/63	14:00	2:50			16:50	1	(1) Engineers replaced cards controlling binary that were in question and replaced solar cell. IBM tests ran correctly but a test run on binary production decks had 5 errors out of 18 runs.
4/9/63	19:19		:05	:25	19:49	1	(1) Binary trouble continues
4/10/63	15:15	3:00	:15	1:25	19:55	1	(1) Binary trouble. (Engineers checked timing cycle of machine and Input-Output programs)
4/11/63	19:56		:10		20:06	2	(1) Binary trouble continues (2) Format errors appearing - first and last page ejects not working correctly.
4/12/63	15:05	3:35	:10	1:10	20:00	3	(1) 1402 reader will not read properly. Broken points on card sensing contacts found to be the trouble. (2) Binary trouble continues. (3) Stacker does not stop when full.
4/15/63	15:25	:20		:15	16:00	1	(1) Binary trouble continues. Engineering inspected read feed and adjusted stacker.
4/16/63	19:32	:15	:10	:35	20:32	2	(1) Binary trouble continues. (2) Spring in door of 729 V tape unit A was broken.

TABLE III - CONTINUED

DATE	RUNNING OK TIME	UNSCHEDULED ENGINEERING	MAINTENANCE	IDLE	TOTAL RUNNING TIME	FAILURES	IBM 1401 DAILY TIME DISTRIBUTION
4/17/63	17:40	2:30	:15	:45	21:10	1	(1) Binary trouble continues. Engineering for binary trouble. Cycle time on 1401 was slowed down but trouble did not disappear.
4/18/63	15:48	4:10			19:58	3	(1) Continuous sync. checks on 1403 printer. Trouble caused by binding chain which in turn was caused by burned out coil. (2) Ribbon on 1403 printer wound to the left so badly that printer stopped. (3) Binary trouble continues. Burned out coil was replaced on 1403 printer.
4/19/63	13:05	2:55			16:00	1	(1) Binary trouble continues.
4/20/63	3:07	1:58			5:05	2	(1) Having continuous reader checks on 1402 reader. Engineer replaced faulty contacts and lubricated 1402 read/punch unit. (2) Binary trouble continues
4/22/63	12:05	3:50	:05		16:00	1	(1) Binary trouble continues. Engineered on 1401 to find binary trouble, but nothing found. Ran with 1401 slowed down for 2 days, but still had random binary errors.
4/23/63	18:33	1:43			20:16	2	(1) Binary trouble continues. (2) Transport error in 1402 reader. Stacker No. 1 failed to halt machine when full. Stacker adjusted.
4/24/63	19:52		:05		19:57	3	(1) Several tape errors on reel No. 114. Tape removed for testing. (2) Reader guide on 1402 reader broke. Spring replaced. (3) Binary trouble continues.
4/25/63	20:48		:05	:05	20:58	1	(1) Binary trouble continues.
4/26/63	18:47	:45	:10	:30	20:12	3	(1) Carriage control on 1403 printer ejected very erratically. Replaced bad brush and retimed carriage control cycle. (2) Binary trouble continues. (3) Ribbon on 1403 printer wound to the left and stopped carriage.

DATE	RUNNING OK TIME	UNSCHEDULED ENGINEERING	MAINTENANCE	IDLE	TOTAL RUNNING TIME	FAILURES	IBM 1401 DAILY TIME DISTRIBUTION
4/27/63	5:05			3:50	8:55	1	(1) Binary trouble continues.
4/29/63	15:50		:10		16:00	1	(1) Binary trouble continues.
4/30/63	12:31	7:45			20:16		Engineering on 1401 to determine cause of binary trouble. Ran several tests and checked 1401, but binary trouble was not located.
TOTALS	388.08	36:31	2:50	11:33	439:02	37	

TABLE I - IBM 7090

SUMMARY OF USE

April, 1963

Scheduled Engineering	32:23
Unscheduled Engineering	5:07
Air Conditioning	9:45
System Up-Dating	2:11
Production (see Table IV)	371:56
Operator Manipulations (tape changing, cleaning, etc.)	92:39
	514:01

TABLE II - IBM 7090

SUMMARY OF MACHINE ERRORS

April, 1963

7090	15
7631 Desk File Control Unit	1
729 VI Tape Units	3
721 Punch	2
711 Reader	1
Air Conditioning	3
	25

DATE	RUNNING OK TIME	SCHED. ENG.	UNSCHED. ENG.	AIR CONDIT.	OPER. MANIP.	TOTAL TIME	ERRORS	IBM 7090 DAILY TIME DISTRIBUTION
4/1/63	10:46	2:00			3:14	16:00	2	(1) Tape unit 'U' had write skew. Engineers adjusted tape unit 'U'. (2) Many write errors on tape unit 'R' but all were attempt of less than 100 times and writing continued OK.
4/2/63	10:49	2:10	:15		5:21	18:35	3	(1) Illegal halt at 06075 and could not get past it. Then it failed on the input portion of the IOS. (2) Machine error in updating. Had to update 4 master tapes before a good one was written. Not sure whether it is tape trouble, machine trouble, or tape unit trouble. (3) Engineers did maintenance on 721 punch.
4/3/63	6:59	:30		4:50	5:32	17:51	1	(1) I/O power check. 7607 II power check because room temperature was too high. Air conditioning down until 0900 on 4/4/63
4/4/63	10:20	1:35		1:00	3:05	16:00		
4/5/63	18:44	1:30			3:46	24:00		
4/6/63	8:00		2:45			10:45	1	(1) RPQ diagram on direct data for IBM 7090 had different cable assignments than the present 7090. The cables were interchanged and sense lines of the DDC all checked out OK.
4/8/63	9:34	1:45	:10		4:31	16:00		Running binary jobs for 1401.
4/9/63	18:45	1:30	:10		3:35	24:00		Running binary jobs for 1401.
4/10/63	21:09	1:30			1:21	24:00		
4/11/63	9:20	1:15			6:54	17:29	1	(1) Several illegal 06103 halts due to machine error occured. Trouble not found.
4/12/63	9:13		1:17	1:35	2:47	14:52	2	(1) Machine errors at location 06103. Trouble not found. (2) Tape unit B7 could not be selected. Trouble due to open circuit in 7909.
4/13/63	24:00					24:00		
4/14/63	18:00					18:00		
4/15/63	10:55	2:30			2:35	16:00		Put in new alarm for room air conditioning unit.
4/16/63	19:09	1:35			3:16	24:00	1	(1) Machine error causing 7090 to halt at location 06103. Trouble not found.
4/17/63	17:18	1:15			3:57	22:30	2	(1) Circuit breaker out on 7631 Desk File. (2) Machine errors at location 06103.

TABLE III - CONTINUED

DATE	RUNNING OK TIME	SCHED. ENG.	UNSCHED. ENG.	AIR CONDIT.	OPER. MANIP.	TOTAL TIME	ERRORS	IBM 7090 DAILY TIME DISTRIBUTION
4/18/63	16:03	1:00			6:57	24:00	1	(1) Write skew errors on tape unit u. Engineers adjusted tape unit u.
4/19/63	15:59	:30			7:31	24:00	1	(1) Machine errors at location 06105 causing 7090 to halt.
4/20/63	7:14					7:14		
4/22/63	11:27	1:45			2:48	16:00		
4/23/63	16:36				7:24	24:00	1	(1) Machine error causing 7090 to halt at location 06105.
4/24/63	11:52	1:45	:30		4:03	18:10	2	(1) Power check light on Multiplexor. Probably caused by high temperature. (2) Machine errors at location 06105 causing 7090 to halt.
4/25/63	17:23	1:47			4:50	24:00	1	(1) Machine error at location 06105 causing 7090 to halt.
4/26/63	18:08	2:00			3:52	24:00	1	(1) Same as above.
4/27/63	8:35					8:35		
4/29/63	11:25	2:00			2:35	16:00	1	(1) Same as above.
4/30/63	16:24	2:31		2:20	2:45	24:00	4	(1) Punch error in punching cards on on-line. Reason unknown. (2) Reader error in reading cards on-line. Reason unknown. (3) Machine error at location 06105. (4) Air conditioning system not functioning properly.
	324:07	32:23	5:07	9:45	92:39	514:01	25	

Departments	Number of Runs: Class	Number of Runs: Research	Number of Runs: Non system	Total Number of Runs	Number of Prob. Specs.: Class	Number of Prob. Specs.: Research	Number of Prob. Specs.: Non system	Total Number of Prob. Specs.	Time Used: Class	Time Used: Research	Time Used: Non system	Total Running Time
Aeronautical and Astronautical Engineering	41	30		71	3	2		5	:23	:20		:43
Agricultural Engineering		32		32		3		3		:33		:33
Agricultural Economics		69	24	93		4	4	8		:29	8:26	8:55
Agronomy		77		77		12		12		1:35		1:35
Animal Science		3		3		1		1		:11		:11
Astronomy		48		48		5		5		:28		:28
Bureau of Community Planning		3		3		1		1		:18		:18
Civil Engineering	308	672		980	7	31		38	2:41	24:59		27:40
Chemistry and Chemical Engineering		886		886		32		32		21:59		21:59
Communications		66		66		3		3		:32		:32
Digital Computer Laboratory	217	655	47	919	1	20	6	27	2:09	19:18	151:11	172:38
Dairy Science		46		46		1		1		:54		:54
Education		43		43		4		4		1:28		1:28
Electrical Engineering	608	291		899	9	17		26	8:01	4:56		12:57
General Engineering		3		3		1		1		:08		:08
Geology		16		16		2		2		:36		:36
Horticulture		2		2		1		1		:01		:01
Institute of Communications Research		72		72		3		3		3:04		3:04
Industrial Engineering	94	7		101	2	1		3	:34	:10		:44
Industrial Education		1		1	2	1		1		:04		:04
Institute of Government and Public Affairs		4		4		1		1		:03		:03
Instructional TV		49		49		3		3		1:28		1:28
Labor and Industrial Relations		4		4		1		1		:05		:05
Mathematics	3404	16		3420	6	1		7	21:42	:06		21:48
Mechanical Engineering	34	405		439	2	20		22	:13	18:41		18:54
Medicine		2		2		1		1		:06		:06
Marketing		9		9		1		1		:11		:11
Mining, Metallurgy and Petroleum Engineering		59		59		3		3		:53		:53
Men's Residence Hall Association Rocket Club		21		21		1		1		:17		:17

TABLE IV - IBM 7090 USE BY DEPARTMENTS (CONTINUED) APRIL, 1963

Departments	Number of Runs: Class	Number of Runs: Research	Number of Runs: Non system	Total Number of Runs	Number of Prob. Specs.: Class	Number of Prob. Specs.: Research	Number of Prob. Specs.: Non system	Total number of Prob. Spec.	Time Used: Class	Time Used: Research	Time Used: Non System	Total Running Time
Music		22		22		2		2		:22		:22
Natural History Survey		1		1		1		1		:01		:01
Nuclear Engineering	43	35		78	1	2		3	:24	:18		:42
Office of Instructional Research		11		11		2		2		:13		:13
Physical Education for Women		3		3		1		1		:07		:07
Physics	110	822	1	933	2	24	1	27	2:56	25:54	:20	29:10
Physiology	1			1	1			1	:01			:01
Plant Pathology		12		12		1		1		:07		:07
Psychology	1	256		257	1	20		21	:01	15:35		15:36
State Geological Survey		10		10		1		1		3:56		3:56
Small Homes Council, Bureau of		9		9		1		1		:13		:13
Residential Construction												
Sociology		42		42		1		1		:37		:37
Statistical Services Unit		257		257		3		3		13:01		13:01
State Water Survey		86		86		5		5		1:23		1:23
Theoretical and Applied Mechanics	35	312		347	1	9		10	:26	5:20		5:46
Sub Total	4896	5469	72	10437	36	250	11	297	39:31	171:00	159:57	370:28
Instruction						168		168		1:28		1:28
Grand Totals	4896	5469	72	10437	36	418	11	465	39:31	172:28	159:57	371:56

PART VII

GENERAL LABORATORY INFORMATION

Colloquia

"Assembly Language Programming for the New University of Illinois Computer, ILLIAC II," by Professor C. W. Gear, Digital Computer Laboratory, University of Illinois, April 1, 1963

"New Mersenne Primes Discovered by ILLIAC II," by Professor Donald B. Gillies, Digital Computer Laboratory, University of Illinois, April 22, 1963

"Microwave Logic Circuits Using Tunnel Diodes," by Professor Yasuo Komamiya, Visiting Research Associate Professor, Digital Computer Laboratory, University of Illinois, and Chief of the Applied Mathematics Section of Electrotechnical Laboratory, Japanese Government, Tokyo, Japan, April 29, 1963

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-Time	Part-Time	Full-time Equivalent
Faculty	15	1	15.5
Visiting Faculty	3	0	3.0
Research Associates	4	0	4.0
Graduate Research Assistants	6	35	23.5
Graduate Teaching Assistants	0	4	2.0
Research Engineer	1	0	1.0
Administrative and Clerical	8	0	8.0
Other Nonacademic Personnel	42	68	66.8
TOTAL	79	108	123.8

The Computer Advisory Committee consists of Professors H. C. Brearley, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During April a total of 142 drawings were processed by both drafting sections:

	General and ILLIAC II	Pattern Recognition
Large Drawings	9	1
Medium Drawings	1	1
Small Drawings	0	0
Reports	78	14
Printed Circuits	0	6
Change Orders	12	0
Miscellaneous	20	0
TOTAL	120	22

(E. Corso and K. C. Law)

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM
PART II - ILLIAC II SYSTEM PROGRAMMING AND OPERATION
PART III - CIRCUIT RESEARCH PROGRAM
PART IV - SWITCHING THEORY
PART V - DATA REDUCTION METHODS
PART VI - IBM 7090-1401 SYSTEM
PART VII - GENERAL LABORATORY INFORMATION

MAY 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction

In terms of transistors counts the following progress has been made during May

Chassis dc checked	3,562
Chassis inspected	171
Chassis wired	0
Chassis layout	1,221
Printed circuit boards wired (100 boards)	716

(T. Kerkering, F. Serio)

2. Main Frame Checks

All of MAU F-elements were tested by the addition of current to common emitter nodes. The test resistor through which current is supplied from +25 volts was chosen to display about ten per cent failures. Using ETR as the test routine the following resulted:

F-Element Type	M	R-Q	A-S
Total tested	44	88	132
Number failed	5	14	15
Test resistor (connected to +25 v)	2.0 K	1.3 K	1.4 K
Added current	13 ma	20 ma	18 ma

All regulators in bays 1-8 front and 1-8 rear tolerate ± 10 per cent margin on all voltages before failure results using ETR. All of the failure prints indicated marginal elements in flow gating.

All flowflops were checked with ETR running using 1 K to +25 volt and 18 K to -50 volt. All write "0" drivers were checked with 2 K to +25 volt. There were no failures.

The conclusions are that flow gating needs another test program and more marginal testing before much can be done to get an idea of the real state of MAU.

(C. E. Carter)

3. Component Testing

Acceptance tests have been run on 6,000 transistors including 3,000 2N967 and on 9,200 diodes including 6,000 TI51.

Detailed evaluation data has been taken on approximately 90 devices.

(B. Doden)

4. Core Memory

The Digit line terminating resistors have been rewired to reduce the effect of +65-volt noise. Some improvement in operation is noted.

Approximately 100 jumpers have been installed to allow observation of selected word currents in the Upper Stack.

(R. Kingsley)

5. Interplay

Checkout of the 1401 channel control (ICC7) was started the latter part of this month.

IPL signals were examined a little more closely also this month.

Interplay Control power has been separated from core turn-on to improve operational versatility.

(R. Kingsley, S. Krabbe, H. Lopeman)

6. Drum

File No. 532 was prepared on the partial erasure problem. New clock tracks have been written as described in File No. 535.

(M. Freedman)

Experimentation with the peak detector led to a modified design. A full chassis is now being built with this modification. The Bit Pattern Generator has been revised and improved in speed.

(M. Freedman, S. Krabbe, B. Levy)

7. IBM 1401 Channel

The 1401 Interplay Channel was completed and checkout has commenced. Static offline checkout was complete and dynamic testing is at present in process.

8. IBM 1414 Channel

The channel command structure, design philosophy, and the majority of logic has been fairly well fixed. Four out of the nine or ten racks which will comprise this channel have been completed.

(M. Pisterzi, R. Willard, Y. Yen)

9. Pattern Recognition Channel

Logical design of the first PRC channel is underway. This logic will occupy five racks. Rack a will contain all pallet boards. Fifty-three word buffer registers will be contained in rack b and rack c. Drivers, terminators and ICC NOR logic circuits will occupy rack d and rack e.

(Y. Yen)

10. Engineering Test Programming

Several test programs were written to test conjectures concerning the operation of the parity circuit in the core memory. The "Parity Bit Oscillate" test, which causes words of alternating parity to be written or real at maximum access speed, has been issued as test routine P1-PBO-46v.

(M. Levin)

Several tests which proved to be useful in the past have been assembled into the Divide-Add-Multiply-Normalize test.

(J. Bouknight, G. Cooper, G. Metze, B. Whitten)

Investigations of user's programs which cause frequent parity errors or yield inconsistent results continue in the hope that the offending program segments can be isolated, extracted, and incorporated into test programs. The "extractions" produced so far do not fail the same way as the original program does.

(M. Levin, G. Metze)

Work has been started on test routines for the 1401 channel.

(J. Bouknight)

PART II

ILLIAC II SYSTEM PROGRAMMING AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Subroutine Write-ups

No subroutine write-ups are being issued until the card equipment is connected and the new assembler is working. However, a number of routines are written in the language of System II. They are listed below and if you wish to use them, you should contact the person indicated.

Sine-Cosine	Paper Tape Library
Decimal Read-In (Paper Tape)	
Decimal Print (Paper Tape)	
Exponential	
Divided Differences	
Romberg Integration	
Merge Two Ordered Lists of Words, Key in Any Quarter Word	Nievergelt
Sort One List of Words, Key in Any Quarter Word	
Six-point Equal-Interval Lagrange Interpolation	Gear
Unequal-Interval Lagrange Interpolation	
Generalized Multistep Integration of Simultaneous Differential Equations	
Roots of a Real or Complex Polynomial by Muller's Method	Brower
Square Root	
Complex Square Root, Multiply and Divide	
Logarithm (Base 2, e, and 10)	Gaer

2. <u>Programming</u>

An Inverse Laplace Transformations subroutine has been coded and is presently being code checked.

The polynomial root subroutine has been code checked.

(E. Brower)

Card Input-Output subroutines are being checked out.

(M. Gaer)

3. <u>NICAP Assembler</u>

Progress has been continuing on the NICAP Assembly Program. Programs are now being written to introduce the 1401 to its functions and are being tested off-line. A provisional report called "Macro-Instructions in NICAP" is in preparation.

(H. Jarosch)

4. <u>ILLIAC II Operations</u>

Code Checking		27:42
Engineering		280:56
Engineering Test Routines		194:24
ETR	71:18	
ASMD	10:42	
Duplex Memory	2:21	
Memory Reversing	45:43	
DAMN	64:20	
Production		
Mersenne Primes		53:57
Fosdick-Jordan		78:22
Demonstrations		1:30
Open House		20:54
Idle		4:40
Power Off (during working day)		3:25
TOTAL TIME		665:50

5. Errors

Punch	2
Reader	1
Core Parity	19
*Power Dump	7
Unknown	6
TOTAL	35

*Power Dumps during engineering periods not counted.

(W. L. Huffman)

6. Bad Components

Transistors		
Spontaneous Failure	6	
Caused by Other Failure	2	
Caused by Accident	1	
End of Life	2	
		11
Diodes		
Spontaneous Failure	4	
		4
Capacitors		2
Resistors		4
Solder Joints		3
Bad Leads		4
Fuses		1
TOTAL		29

(W. L. Huffman)

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Henry Guckel made considerable progress analyzing the variations of performance of his coupled transmission line amplifier as a function of (1) the tolerances on the negative resistance of the tunnel diodes and the position of the inflection point, (2) the tolerances on the positive terminating resistances. The main result is that these tolerances essentially affect the lower cutoff frequency.

Louis van Biljon has proposed a new mechanism to explain the very different avalanche breakdown curves of diffused and alloyed transistors: the explanation compares essentially the RI field in the base to the built-in field. It appears that when one takes account of these effects, the original Miller theory of breakdown holds.

Gabor Ujhelyi has taken the first steps towards a study of laser logic. After comparing the systems available on the market, one produced by Maser Optics, Inc., was ordered. The first goal is to study the rise and fall times of emitted light pulses as a function of the stored energy.

2. Tunnel Diodes and Coupled Transmission Lines

The entire month has been devoted to work connected with distributed circuits. Since the theory is essentially complete for mathematical systems rather than real systems, efforts have been made to determine the effect of tolerances on the ideal system. In order to obtain order of magnitude information on tolerance variations of tunnel diodes, five samples of Microstate's 5-ma Ga As diodes were examined (MS 1550). The results were rather encouraging: at the inflection point the negative resistance of all samples was found to be 35.4 ± .15 ohms. This would support an earlier claim of Microstate to be able to deliver diodes with a specified resistance magnitude ± 1 per cent. However, the inflection point itself is subject to tolerance restrictions. Whether this is harmful or not will depend on the use of single diodes or Goto pairs. Some selection may be necessary. Contact with Film Ohm Corporation was established

to discuss the positive resistor shape and tolerances. A one per cent resistor in the strip line shape seems to be no major problem. These results lead to the conclusion that tolerance magnitudes will not be any worse than for transistor circuits; however, their effects differ.

Re-examination of the principal equations of the theory results in the following conclusions. The coefficient determinant and all its minors of the first row contain the factor $(\epsilon^{s\sqrt{\mu\epsilon}\, 2\ell} - 1)$. Hence, at the half-wave line resonance of the structure all minors and the determinant vanish. The coefficients of the ideal system (Δ_{1i}/Δ) do not exhibit the line resonance because these terms cancel. However, in the nonperfect system this argument no longer holds. It is easy to show that the five determinants are indeed nonzero at this frequency. Therefore, disturbances will result. The magnitudes of these have been studied by the use of numerical examples via the 7090 and analytical methods. Two conclusions have been reached: the low frequency response is a function of the tolerances. The half-wave resonance should be made to occur at the highest possible frequency, i.e., a minimum line length should be used. The first point has been verified experimentally. It is not a serious problem since at the frequencies involved both line parameters will be functions of frequency due to flux penetrations into the conductors. The second point results in an upper distortion-free frequency bound. This seems to be about 3000 mc but at this frequency diodes performance will be down quite a bit. Tolerances will thus degrade the system not any more than they would a lumped system.

During the last series of experiments it was noted that a bias change, which would result in a change of sign of the negative resistor to a positive one, caused complete interruption of transmission from the input port of the primary line to the output port of the secondary line. This type of control could thus act as a gate. The relation of this phenomena to backward couplers is being studied.

A final report on the work up to this point is under preparation.

3. Avalanche Effect

Accurate measurements of collector current as a function of collector-base voltage have been made on GF45011-type mesa transistors. I_{CO} was measured, and thereafter I_C at three values of I_E, viz., 5, 10 and 5 μa--the circuit used is shown in Fig. 1.

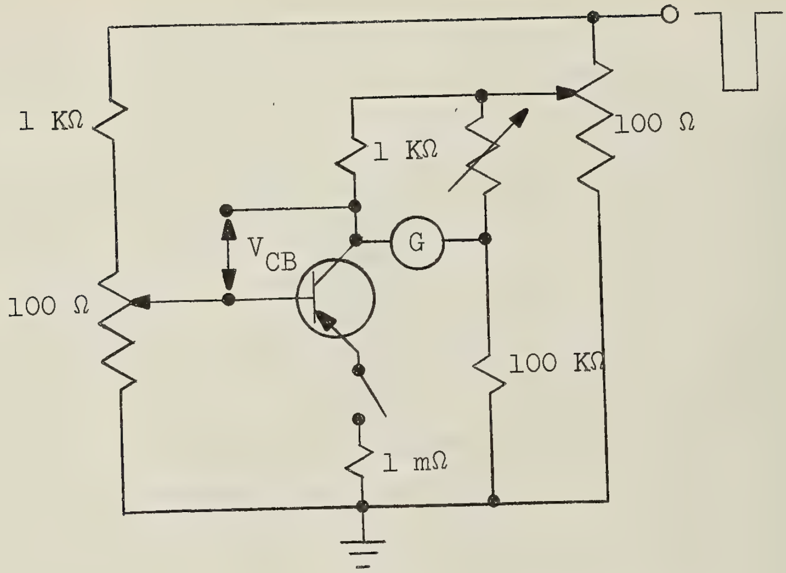


Figure 1. Collector Current Test Circuit

The values of $(\alpha_o M)$ and M, as found from the equation:

$$I_C = (\alpha_o M)I_E + MI_{COO}$$

for a particular transistor, are plotted in Fig. 2, showing the descrepancy observed. The values of $(\alpha_o M)$ found at the three values of I_E, were equal within experimental error. For comparison, M, as found from Miller's[1] empirical relation

$$M_M = \frac{1}{1 - \left(\frac{V}{V_B}\right)^3}$$

is also shown, V_B having been taken as 36 volts.

The first point to note is that $(\alpha_o M)$ and Miller's M, M_M, show fair correspondence while $M_{I_{CO}}$ obviously follows some other law. The first conclusions to be drawn here, probably are twofold, both points to the fact that the factor M cannot be found from direct interpretation of I_{CO} data.

---

[1] S. L. Miller. Phys. Rev., Aug 15, 1955.

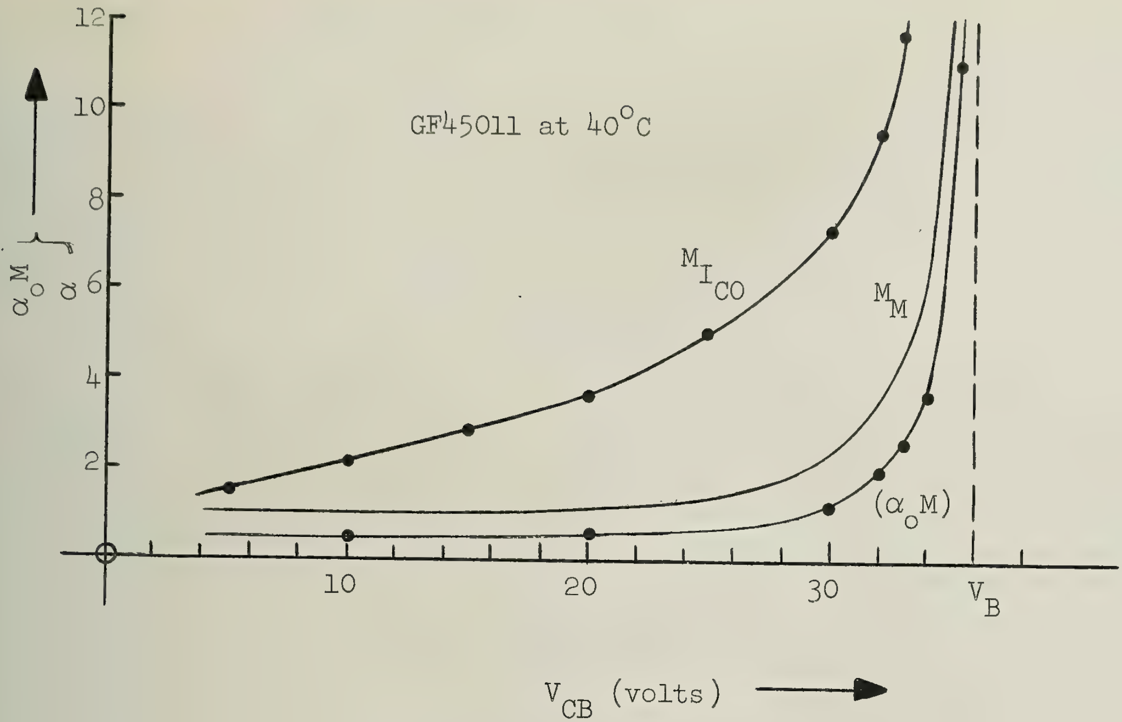


Figure 2. $\alpha_o M$ and M versus V_{CB}

First, the obvious effect of leakage current across the junction has been neglected. It is assumed that leakage current alone causes the difference between $M_{I_{CO}}$ and M_M; a leakage resistance as shown in Fig. 3 would explain the difference.

However, considering the careful construction of this type of transistor it is thought that so large a variation in leakage resistance is unlikely to occur over the range of voltage considered. Furthermore, a second effort which should be taken account of, expecially in diffused-base transistors, is depletion region.[2] Making an approximate evaluation of this effect, the supposed variation of the leakage resistance will be as shown by the dotted line in Fig. 3.

Second, a very likely cause for the descrepancy in experimental and calculated values is that of an ohmic voltage drop in the base, establishing a field aiding the transport of carriers from the base to the collector. Considering that the thermal-generated saturation current, flowing toward the collector, encounters some resistance en route to the depletion layer, a field will be established, directed as shown in Fig. 4.

[2] Sah, Noyce and Shockley. Proc. IRE, Sept., 1957.

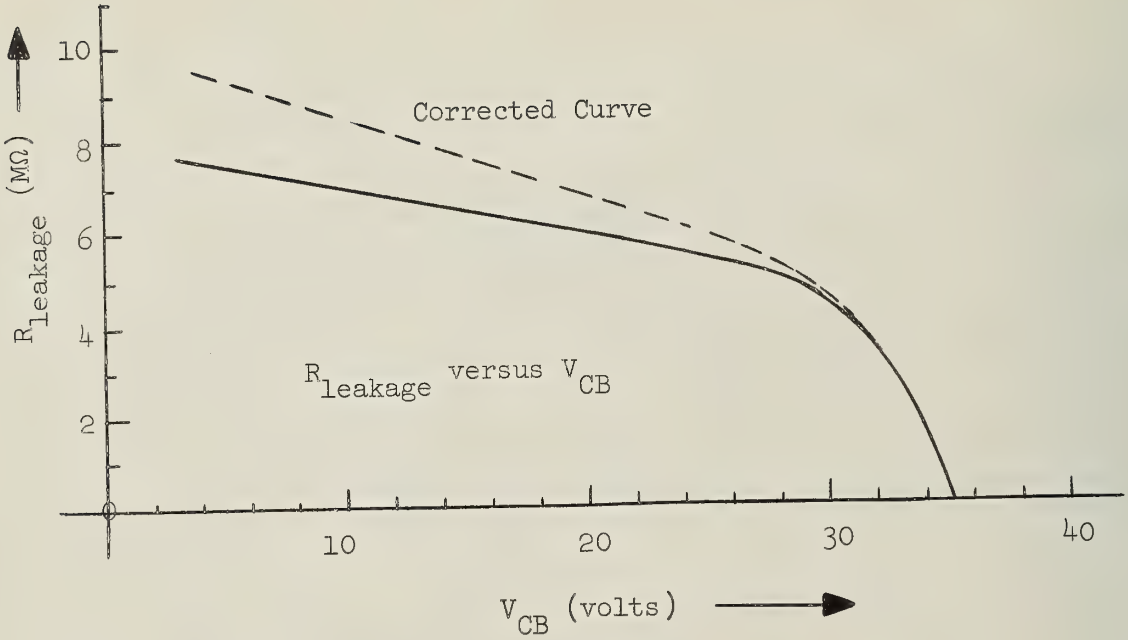


Figure 3. Variation of Leakage Resistance

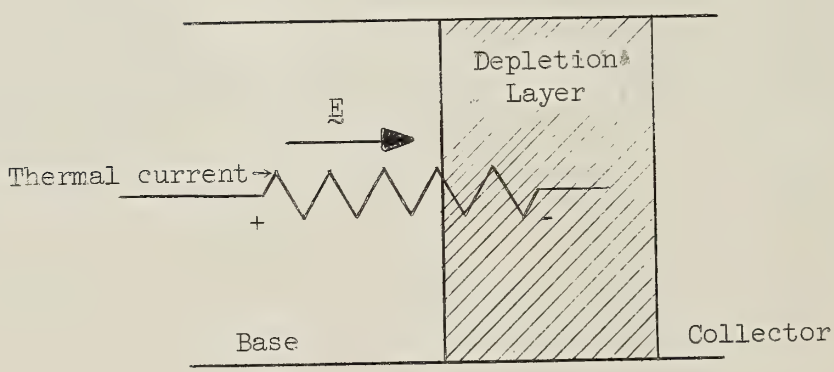


Figure 4. Electric Field in the Base and the Depletion Region

This field effect (which has been observed by Pell[3] in diodes) will aid the flow of carriers which will in itself again strengthen the field. This

[3] E. M. Pell. Journal of Appl. Phys., April, 1957.

mechanism, in conjunction with multiplication, could conceivably initiate a breakdown even before M itself would have become infinite. Essentially the process described would be current dependent--some evidence in support of this view is offered by the set of I_C - V_{CB} curves shown in Fig. 5 where $\Delta I_C/\Delta V_{CB}$ increases with current.

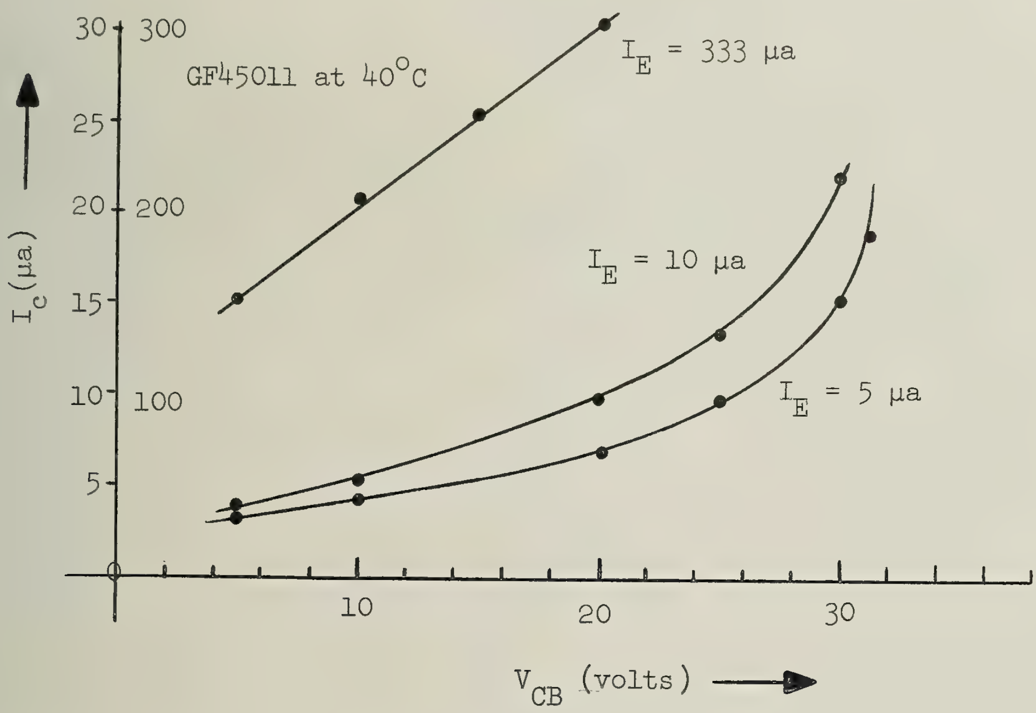


Figure 5. I_C versus V_{CB}

(These are actual readings of I_C and thus include I_{CO}.)

To arrive at a numerical evaluation of the above effect, the charge transfer across the base, aided by a field which is a function of the current represented by this charge transfer, has to be analyzed. For the simplest case, solving for the collector circuit density, one finds:

$$I_C = i \cdot M + f(V_{CB})$$

where $f(V_{CB})$ represents the influence of the leakage resistance; where i is found from the conventional charge transfer equation across a transistor base. To keep the equations manageable it must be assumed that at the base-collector edge,

the hole concentration is zero. This causes the current to consist solely of diffusion current at this point. However, the influence of the electric field is incorporated in the magnitude of the slope of the concentration, i.e., in $(\frac{dp}{dx})$ and thus makes its effect felt. From these considerations one finds for i:

$$i = qD_p \frac{p_n}{z} \left(\frac{\epsilon^-}{e^{-\frac{w}{2}\epsilon^-} - 1} \right) \text{amps/m}^2$$

with

$$\epsilon^- = \frac{q\underset{\sim}{E}}{kT} - \sqrt{\left(\frac{q\underset{\sim}{E}}{kT}\right)^2 + \frac{4}{D_p x}}$$

$$w = \text{base width}$$

and

$$\underset{\sim}{E} = J_C \cdot \rho \qquad (\rho = \text{resistivity})$$

By a process of curve fitting it may be possible to find a value for ρ representative of base resistivity in the region concerned; this would offer some support for the mechanism of breakdown described above. Also, in alloy junction transistors where normally no field is present in the base, it would seem as if the field effect described above is more noticeable since an I_{CO} versus V_{CB} characteristic on such a transistor rarely shows a definite breakdown voltage--curve A, Fig. 6. A diffused base transistor, however, where an initial field already is present exhibits a curve like "B" in Fig. 6.

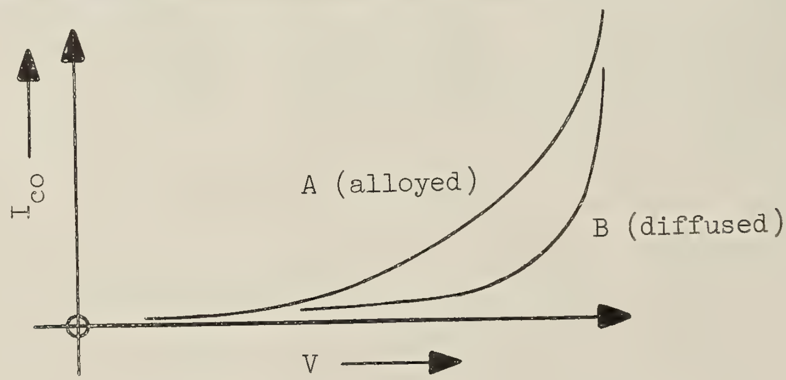


Figure 6. I_{CO} versus V for Diffused and Alloyed Transistors

3. Laser Logic

Comparative data was compiled for the commercially available solid state (ruby), gas and Ga As junction lasers. It was decided subsequently that for the first series of rise time, triggering and modulation experiments the Maser Optics, Inc., Series 600 ruby laser system is sufficient and steps were taken toward purchasing one of these systems.

A method of modulation of light intensity by an electric signal was studied, and it was found that the intensity of a narrow, well-collimated, polarized light beam can be controlled by a reasonably low voltage (300 volts maximum), very low power signal. (A preliminary report on these studies was given in File No. 537.) The experimental verification of this theoretical work remains to be done; the experimental apparatus is being assembled at the present.

PART IV

SWITCHING THEORY

(Supported in part by the Office of Naval Research under Contract Nonr-1834(27).)

1. The work of Mr. Clinton R. Foulk on cyclic error correcting codes which correct two and three dimensional spot errors has been completed and forms his doctoral thesis. It is also to be a laboratory report.

2. The work of Mr. William A. Wulf on nondeterministic automata has been completed and is to be a laboratory file number.

3. The work on infinite sequences described in File No. 526 is being extended to include the asynchronous case.

(David E. Muller)

PART V

DATA REDUCTION METHODS

(Supported in part by Contract No. AT(11-1)-1018 of the Atomic Energy Commission)

Pattern Recognition: Simulator Studies

(For a previous summary, see Technical Progress Report, November, 1962, pp. 23-25. The following is a report on the work done in the six months since then.)

A two-stage recognition procedure for scanning bubble-chamber negatives was described in the report referred to above. The structure of a program for implementing this scheme has been worked out in complete detail. (This has been issued as File No. 507, February, 1963.) This program consists of two more or less independent systems. The first, called the MAIN program, is concerned with all the administrative details, with the compilation of all the accumulated information, the bookkeeping, flow of information, sequencing and so on. Effectively it is an executive system.

The second subsystem which operates entirely in the PAU mode consists again of two program units. The first, called LABEL, is concerned with the labeling procedures. The second, called SEARCH, consists of the search algorithms which perform the actual updating of the lists through the current window.

SEARCH and MAIN communicate through a fixed set of information cells and a control cell termed STATE SWITCH (SS). The sequencing at any given stage in compilation proceeds as follows: the MAIN program loads the proper input cells with the relevant information and sets the INPUT STATE of SS. SEARCH functions very much like a finite state machine. Depending upon the input configurations (specified by MAIN) and the window configurations (prescribed by the labels), it sets SS to a specific OUTPUT STATE and OUTPUT CODE. MAIN now selects an entry, as determined by the total configuration os SS, from a compilation table and carries out the compilation as directed in the entry. The entire procedure, thus, is quite analogous to the functioning of a syntax-directed compiler.

The following is the current status of the implementation of the above program:

1. LABEL

The complete labeling algorithm has been written and tested on several hand-digitized bubble-chamber input picture segments. The algorithm converts the input picture into a labeled graph with the following information: it assigns one of the labels N, E, A, B to the branches, assigns direction numbers to the basic sets (i.e., vertices, bends, cross-overs, terminals) to indicate the local orientation of the roads which meet there, divides the basic sets into two groups--those that lie on the window walls and those that lie in the interior; it selects a representative point for each of the wall basic sets. The details of this program are currently being written up and will be issued as a file number soon.

SEARCH

The flow charts for a first version of the search algorithms have been worked out. The coding for IBM 7090 will be taken up after the summer recess.

(R. Narasimhan, R. K. Rice)

2. MAIN

This program will be written in the SCATRE language exploiting to the full the macro-facilities contained in it. As a first step, the complete details of the compilation phase have been worked out. These involve: (1) a procedure for transferring control between MAIN and SEARCH, (2) encoding of the STATE SWITCH configurations, and (3) construction of the compilation table. The table entries will be assembled using a set of about 100 macros. A file number describing these is currently being printed and will be available soon.

(B. H. Mayoh, R. Narasimhan)

The actual implementation of this program in the IBM 7090 will be carried out in three stages. In stage 1, the table entries and SS configurations realized will enable the processing of pictures consisting only of beam tracks. In stage 2, this will be extended to include spirals, helices, etc. In stage 3, vertices will be identified. This will essentially complete the realization

of the entire program except for refinement in the search algorithms. It is hoped coding for stage 1 can be completed by the end of October, 1963.

(R. Narasimhan)

3. PAX

The first version described in File No. 513, is currently being revised with the addition of more parallel processing functions. The principal ones added are: Z-Read, List Coordinates, Write-Z, Punch Output, and an operation called BOOFUN, to realize general homogeneous logic transformations. The revised version, incorporating a description of the internal functioning of PAX, should be available soon.

(J. H. Stein)

4. PREPROCESSING

It is envisaged that a certain amount of preprocessing (i.e., gap filling and thinning) of digitized pictures will be necessary before they can be adequately handled by the above programs. With this in view, several general purpose filling and thinning routines have been developed. One version of this noise-clearing program is currently being extended to exploit optimally the known syntactic features of bubble-chamber pictures.

(Jim Fornango, Larry Nelson,
R. Narasimhan)

PART VI

IBM 7090-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

During the month of May five new routines were added to the 7090 Library.

F4-UØI-LSQ1-31-FR

Least Square Polynomial Fit (FØRTRAN II) (minimum 7090). This is a FØRTRAN II subroutine.

Given a set of N values of an independent variable X, with associated weights W, and one or more sets of corresponding values of Y; the routine determines the coefficients of the polynomial(s) of degree M-1 which gives the best fit in the least squares sense to the set(s) of Y. In addition, the residuals, the weighted sum(s) of squares of residuals, and the error matrix are computed.

Originally programmed for IBM 704 by Burton S. Garbow - May 25, 1959, Argonne National Laboratory, Lemont, Illinois.

(D. Hutchinson)

F4-UØI-LSQ2-32-FR

A General Program for Least Square Polynomial Fit (FØRTRAN II) Minimum 7090. This is a complete or "canned" program. The user need do no programming. An input-output structure with various options is built around subroutine LSQ1 for the determination of the coefficients of the polynomial of specified degree which best fits, in the least squares sense, the supplied data.

Originally programmed for IBM 704 by Burton S. Garbow - August 22, 1961, Argonne National Laboratory, Lemont, Illinois.

(D. Hutchinson)

J5-UØI-PLØT-33-RX

<u>Plot Graphs on the Off-Line Printer</u>. This routine provides rapid machine plotting of numeric information for use with FØRTRAN, SCATRE or MAD calling programs. The resulting graph is copied onto any decimal output tape for subsequent off-line (or simulated off-line) printing or punching.

The possibility of using the cathode ray tube and subroutines SCP1 and SCP2 should be considered. The CRT is much faster and provides far better resolution than plotting with the printer. Plotting with the printer provides only 100 resolvable points horizontally. The CRT has 1024 points horizontally and vertically and at least 256 of these are resolvable.

This routine was programmed at the University of Michigan Computing Center - March 1, 1961 - by Brice Carnahan and Larry Evans.

(Revised writeup by D. Hutchinson)

F4-UØI-INV1-34-FR

<u>Matrix Inversion with Accompanying Solution of Linear Equations (FØRTRAN II)</u>. This FØRTRAN II subroutine solves the matrix equation AX = B, where A is a square coefficient matrix and B is a matrix of constant vectors. A^{-1} is also obtained; indeed, inversion may be the sole aim in a particular usage. Finally, the determinant of A is available; other possibly useful information is in CØMMØN storage.

Originally programmed for IBM 704 by Burton S. Garbow - February 23, 1959, Argonne National Laboratory, Lemont, Illinois

(Checked by D. Hutchinson)

G5-UØI-RAN1-35-SR

<u>Generate Floating or Fixed Point Numbers Pseudo-Uniformly Distributed on (0,1).</u>

Fixed point 35 bit numbers:

$$X_{n+1} = (2^9+1)X_n + 27098000001 \quad (\mathrm{mod}\ 2^{35})$$

are generated. Starting with <u>any</u> 35 bit binary integer this well known method will not repeat until all 2^{35} different integers have been generated.

(Programmed by David Hutchinson)

During the month of May, 40 problem specifications were submitted for the IBM 7090.

378-34061 Mathematics. Curve Fitting and Extrapolation. Given a set of points on an unknown type of curve, determine if these points represent any number of common curves (line, elipse, logarithmic, etc.) and, if so, given the independent variable of another set of points on this curve, calculate the dependent variable for each point.

379-34062 Natural History Survey. Relationship of Pheasant Abundance to Land Use in Illinois. This research problem is to determine the statistical relationship, by county, between land-use practices and associated abundance of pheasants in Illinois. Abundance figures represent the mean number of pheasants reported by rural mail carriers in each of Illinois' 102 counties during six counts, 1957 and 1958. Mathematics will involve multiple regression analysis by least squares method. Test statistics will include two dependent variables and ten independent variables, segregrated by county.

380-35001T Chemistry and Chemical Engineering. Polymer Denaturization. This problem will study the denaturization equiubrium between the helical protein-like polymer and the denatured or more random form. Polymers will be machine generated by a biased Monte Carlo routine which maximizes the yield of polymers of interest. Inter-and intrachain interactions simulating hydrogen bonding will be analyzed, and the partition function of both configurations will be calculated. From these data the equiubrium constant is easily calculated.

The 7090 system will do all calculations associated with this problem. Specifically, it will generate the polymers, analyze interactions, calculate partition functions and do general arithmetic.

381-35002 Civil Engineering. Moment Capacity. The only mathematical method used is that of iteration. The computer starts off with a given concrete strain and by a process of successive trials obtains equibibrium of forces on the cross-section. It can then compute the moment capacity for the given concrete strain. The procedure is extended for all concrete strains up to ultimate.

382-35003T Mechanical Engineering. Load Capacity of Non-Involute Gearing. The problem involves the analysis of generated, non-involute, gear profiles and the optimization of these profiles on the basis of load capacity.

The pressure existing in the oil film between the gear profiles will be determined by numerical integration of the pressure gradient using Reynold's boundary-conditions to establish the limits of the film. The load capacity will be determined by numerical integration of the resulting pressure distribution curve.

The computer will be used to determine the limits of the film and to perform the integrations for various sets of parameters which will yield the best possible load capacity.

383-35004T Chemistry and Chemical Engineering. Molecular Calculations. The purpose of this research is to calculate observable molecular quantities for small molecules. Initially the purpose will be to investigate electron pair functions for small molecules, and to determine how well observables calculated from these wave functions agree with experimental data found in the literature. It is expected that allowing for correlation of electrons in the same orbital will result in a closer agreement of calculated and experimentally determined quantities than have been previously obtained.

Programs will need to be developed which make possible the numerical evaluation of the integrals involved in this work. It will probably be found that the integrals cannot be evaluated without using numerical methods, which would absolutely require use of the computer to arrive at satisfactory results.

384-35005T Theoretical and Applied Mechanics. Creep Torsion of A Circular Bar. Creep torsion of a circular bar is concerned with the determination of the angular deformation which occurs under the action of an applied constant torgue due to deformations which are time-dependent. It is intended to make use of the 7090 computer facilities in making the numerous calculations which are involved in the so-called incremental method of analysis. In this method the creep properties of the material of the shaft are represented by an equation of state of the form

$$Y_c = A \left(\frac{Y}{10,000}\right)^n t^m$$

where Y_c = creep strain
A = constant
Y = Stress
t = time
m,n = material constants.

using this equation in conjunction with the equations

$$\gamma_{Total} = \gamma_{elastic} + \frac{4}{b^3} \int_0^b \gamma_c \; r^2 \, dr$$

and $$\gamma_{Elastic} = \gamma_{Total} - \gamma_c$$

one may calculate new stresses at the end of a small time interval from

$\tau = G \, \gamma_{Elastic}$ G = Shearing modulus of elasticity

Now with these new stresses, new increments of creep strain γ_c, for a new time interval can be calculated. Hence repeating the process above yields new values of stress. The process is continued until the total strain γ_{total} is obtained for a specified time.

385-35006 Electrical Engineering. Equivalent Network Generator. The problem is to generate a class of electrical networks from a given network while maintaining a certain network function invariant.

Through suitable formulae and algoritms, this problem may be placed in the form of having to solve N (the number of network elements) simultaneous first order linear differential equations.

386-35007 Theoretical and Applied Mechanics. Geometrical and Dynamical Properties of Shells. The present research is concerned with the determination of the surface areas, volumes, centroids and moments of inertia for a class of shells. The expressions for the line integrals and surface integrals involved in this problem are solved by numerical integration.

The integrands of the integrals contain trigonometric functions and polynomials. Simpson's rule and Weddle's rule for the numerical integration are to be used.

The solutions to the integrals will be listed in tabular form in terms of the parameters of the system.

387-35008T Civil Engineering. Beams on an Elastic Foundation. The problem is to find solutions of beams on elastic foundations subjected to lateral as well as axial loads both for the elastic and inelastic cases. The problem involves the solution of differential equations of 4th order of complex nature.

388-35009T Civil Engineering. Propagation of Stress Waves in A Spherically Symmetric Solid of Elastic - Perfectly Plastic Behavior. The classical theory of continuum dynamics yields a set of partial differential equations for the propagation of stress waves in a solid medium. Instead of seeking solutions to these equations, an alternative problem is considered, which involves digital simulation on high-speed computers. For this purpose a discrete model has been developed for the spherically symmetric solid.

Solid media of full spaces are discretized into masses and springs on a grid work using spherical coordinates. Motions of each mass are given by Newton's second law of motion. Accelerations, velocities, and displacements of each mass are computed by a step-by-step integration process. Using such a process, it is possible to propagate a stress wave through the discrete system.

Problems of elastic and perfectly-plastic materials will be investigated. Solutions of this type have immediate applications in the determination of the response of earth media to underground nuclear explosions.

The IBM 7090 computer is required to perform the iteration process for this problem.

389-35010T Agronomy. Seedling Heterosis and Nitrate Reductase Activity in Corn. The problem is concerned with the relationship between nitrate reductase activity and relative rate of growth of corn inbreds and their hybrid progeny during their vegetative development. The primary nitrogen source for the corn plant is nitrate. Nitrate reductase is the enzyme responsible for catalyzing the reduction of nitrate to nitrite, the first step in a series of reactions which yield ammonia as their product. Ammonia is subsequently incorporated into amino acids. Although nitrate accumulates in corn tissue, the intermediates between nitrate and amino acids are seldom found in high concentrations in healthy corn tissue. This constitutes evidence that nitrate reductase is the rate limiting step in the amino acid synthesizing sequence. Protein synthesis requires the availability of amino acids, and high protein concentrations are known to occur in rapidly growing tissue in corn. Therefore it seems likely that nitrate reductase activity may be related to the accelerated growth of hybrids.

Two groups of four inbreds each and all combinations of single cross hybrids will be grown in the field in randomized complete blocks of three replications. Assays will be run three times a week on each group for nitrate reductase activity, water soluble protein, and nitrate. Plant weight will also be measured three times per week. Weekly, total nitrogen and total nitrate per plant will be assayed, and leaf counts will be made. The experiment will last for three weeks.

The IBM 7090 will be used to convert the results of the assays, read as optical density on a spectrophotometer, to specific activity of the enzyme, milligrams protein per gram fresh weight of corn, and micrograms of nitrate nitrogen per gram fresh weight. An analysis of variance will be run on all data for each sampling date, including single degree of freedom comparisons between each hybrid and its two inbred parents. A combined analysis will be run over all sampling dates. Use of the IBM 7090 will facilitate rapid determination of results as the experiment progresses, and reduce the amount of time spent performing the lengthy analysis.

390-35011 Physics. Theoretical Cross Section Calculations. One indication of the validity of a theory of nuclear reactions is its ability to predict nuclear reaction cross section angular distributions. For this reason a part of the research program currently in progress at the University of Illinois cyclotron involves the measurement of angular distributions and their comparison with theoretical predictions. However, the calculation of theoretical distributions is possible only with the use of a high speed computer. Computer programs now available provide distribution calculations for stripping and elastic scattering reactions. The Illinois cyclotron group has obtained these programs and proposes to use them with the IBM 7090 to analyze both recently completed and future experiments.

390-35012T Electrical Engineering. Flipflop Analysis 1. A phase plane theory of flipflops has been devised. It has been shown that the state transition of symmetric and asymmetric flipflops obeys a nonlinear differential equation of the second order, whereas a general nonsymmetric Eccles-Jordan flipflop obeys a system of two such equations. These equations have been established and some approximate techniques have been devised with the purpose of obtaining the more important aspects of the state transition wave forms without actually solving the nonlinear differential equations. Although these methods have been devised for hand calculation, the computer is needed to solve a number of problems by several different techniques for the purpose of comparison of theoretical with experimental results and consequent evaluation of the theory and its approximate procedures.

392-35013T Industrial Education. Effects of Programmed Instruction Upon Initial Learning, Retention, and Subsequent Learning From A Textbook. The purpose of the study is to investigate the effects of selected teaching treatments upon learning as measured by immediate learning and retention tests, and upon subsequent

learning of another task by reading from a standard textbook.

The subjects, 300 junior high school students, are to be randomly assigned to three experimental treatments (textbook, linear program, and branching program) and to a control group. All subjects will receive a multiple choice test immediately following the treatment and again ten days later. Immediately following the retention tests, all subjects will receive a textbook passage covering an independent learning task. Learning of the second task will be measured immediately upon completion of the reading.

The major statistical treatement will be analysis of covariance. Relevant variables include intelligence and achievement test scores, grade level, age, time on treatments and tests, and test scores.

393-35014T Theoretical and Applied Mechanics. Stresses in A Rotating Mirror. In streak photography the image is swept along a stationary strip of film by means of a polished steel mirror rotating at speeds as high as 10,000 - 15,000 revolutions per second. At these speeds the displacements in the mirror are large enough to cause appreciable distortion of the image. Also, the stresses are quite large. The problem then is to analytically determine the stresses and displacements in the mirror at various speeds.

The stresses and displacements are given by equations of the form:

$$\text{Stress} = K_1 + \sum_{n=1}^{\infty} A_n f(x,y) + \sum_{m=1}^{\infty} B_m g(x,y)$$

$$\text{Displacement} = K_2 + \sum_{n=1}^{\infty} A_n p(x,y) + \sum_{m=1}^{\infty} B_m q(x,y)$$

where K_1 and K_2 are known constants and $f(x,y)$, $g(x,y)$, $p(x,y)$, and $q(x,y)$ are known functions of the coordinate variables x, y. The coefficients A_n and B_m are given by a set of coupled linear equations;

$$A_n = F_n + \sum_{m=1}^{\infty} C_{nm} B_m \qquad B_m = \sum_{n=1}^{\infty} D_{mn} A_n$$

F_n, C_{nm}, D_{mn} are known constants.

The IBM 7090 will be used to solve the linear equations for the coefficients A_n and B_m and to sum the series in the stress and displacement equations.

394-35015T Civil Engineering. Inelastic Column Buckling. This research problem consists of the determination of the lateral torsional buckling strength of as-rolled wide-flange beams subjected to axial compressive force and transverse load in the plane of the web. The beams are of structural carbon steel possessing an ideal elastic-plastic stress-strain curve. A simplified pattern of residual stresses is assumed. The derivatives of the governing differential equations are approximated by finite difference equations. The IBM 7090 will be used to determine the variable coefficients of the differential equations and to obtain solutions by a process of iteration.

395-35016T Industrial Education. Axonometry. This problem is a thesis research to determine differences in effect of teaching methods on the initial learning and transfer of principles of orthographic projection. The subjects are 8th grade boys enrolled in industrial arts for the first time.

The experimental design calls for two treatment groups and a control group. The differential treatments are multiview orthographic projection and isometric drawing as compared to axonometric projection. The primary interest in the study is to determine if students learning one treatment, for example axonometry, can transfer their learning to the other method, in this example, orthographic multiview projection.

The statistical design selected is analysis of covariance because the groups are intact groups and could not be randomly assigned. The analysis of covariance will use the spacial relations test of the Differential Aptitude Test as a pre-test.

The 7090 was selected because of the availability of a good multiple correlation program from which F tests for significance could be computed. The same program will also convert all data to Z scores prior to computing the multiple R's.

396-35017 Digital Computer Laboratory. Sorting. This research problem is concerned with an investigation of sorting techniques. Particular attention will be devoted to the von Newmann sorting scheme and schemes related to it. An attempt will be made to find rules for optimum arrangement of data on the tapes for various kinds of data and data structure.

397-35018T Electrical Engineering. 35Gc Rebatron. The equations to be solved by the computer are concerned with the tragectories of electrons in a periodically loaded microwave accelerating cavity. The results will be compared with the experimental values for electron position and velocity. The equations are

$$\frac{d\beta}{d\theta} = - \alpha(z)\,(1 - \beta^2)^{3/2} \sin\left[\int_{\theta_e}^{\theta_e + \theta} \beta/\beta_W \; d\theta - \theta - \theta_e\right]$$

and

$$\rho = \frac{2\pi z}{\lambda_0} = \int_{\theta_e}^{\theta_e + \theta} \beta \, d\theta,$$

where

$$\alpha(z) = \frac{e\,E(z)\,\lambda_0}{2\pi m_0 c^2}$$ and e is the

magnitude of the electronic charge, $E(z)$ is the magnitude of the traveling wave peak amplitude, λ_0 is the free space wavelength, m_0 is the rest mass of the electron and c is the velocity of light. In addition, β is the electron speed divided by c, θ is time measured in radians, and ρ is normalized position.

398-35020 Psychology. Predicting of Achievement on Programmed Instruction. A semantic differential measuring personality and measuring attitude toward programmed instruction was given to University High School students. These students also took achievement pretests on punctuation and computer programming. They then took a program on English punctuating and a program on computer programming. The semantic differential and the achievement test were retaken as soon as the student finished both programs. The 7090 system will be used to run coefficients of correlations between the achievement measures and the semantic differential.

399-35021T Nuclear Engineering. Fuel Management (Phase I). A study of nuclear reactor fuel management optimization during plant startup and othr fueling transients is being carried out. Phase I covers writing, debugging, and preliminary runs of two optimization schemes, with the aim of obtaining as quickly and painlessly as possible a feel for the behavior of the problem. Later phases will include refinement both to the reactor model and the optimizing schemes.

400-35022 Architecture. Structural Analysis. This research problem involves various methods of structural analysis to solve structural problems of various degrees of indeterminancy. The mathematical methods involved range from simple statics to indeterminant methods of analysis depending on the particular degree of indeterminancy of the structural system in question.

401-35023 Accountancy. An Application of Linear Programming to Accounting System Design. The problem to be processed on the 7090 is the computational procedure involved in solving a linear programming application to accounting system design. A linear programming model consisting of constraining linear equations and an objective function to be minimized has been developed from cost data on the use of accounting machines. The constraint functions basically indicate limitations on two flows of accounting documents and data through the data-processing department of a large oil company. The objective function contains cost data on the operation of various (sometimes alternative) accounting machines mainly processing punched cards. It is hoped that the 7090 solution will indicate in terms of cost the optimal sequence of processing on different machines a monthly routine of 400,000 gas station invoices.

402-35024 State Water Survey. Two-Variable Correlation of Evaporation Data. Several sets of computed and observed evaporation data for several stations for relatively long periods of record are available. Correlation and regression coefficients for computed versus observed data are required. Other statistics such as averages, standard deviations and a standard error of estimate are needed. A Fortran program for the IBM 7090 to obtain the required statistics will be developed.

403-35025T Civil Engineering. Study of Elastic Plates. The analysis of elastic plates may be accomplished with the use of finite difference operators. To obtain acceptable accuracy using this method a large number of simultaneous equations must be generated and solved. The number of equations required prohibits their use unless recourse may be had to a high-speed digital computer.

This program will generate a matrix of linear simultaneous equations by applying finite difference operators to various points on a mathematical model of a plate. The resulting matrix will be solved and the deflections obtained will be printed. Bending moments will be obtained from the deflections and printed.

404-35026 Bureau of Economic and Business Research. Production Functions. The purpose of the research is to simulate time series with known basic properties for the variables labor, capital and output, and then to fit alternative production functions to the data by multiple regression techniques. It is hoped that in this way insight may be gained into our ability, when using actual data, to discriminate statistically among different production functions and to determine their relative suitability. Given the form of the appropriate generator functions and values for the several relevant parameters, the IBM 7090 can be used to generate the three time series iteratively and, subsequently, to perform the regression analysis.

405-35027 Civil Engineering. Critical Path Method Cost Applications. The Critical Path Method will be extended for use in project time and financial control as required in a contracting organization.

406-35028T Psychology. Parent Ratings of Child Behavior. Some 500 children aged 6-10 have been rated on various scales by their parents. The 7090 will be used to analyze this data by factor analysis. Investigation of the results will be done in terms of a circumplex model of child behavior that has been found by a number of investigators.

407-35029T Agronomy. The Hill Reaction in Zea Maize as Affected by Season and Genetic Constitution. The problem is concerned with assaying the Hill Reaction of inbred lines of corn and their hybrids. The Hill Reaction is a photochemical process in green plants whereby water is split with the production of O_2, H ions and electrons. The H ions are used to reduce TPN and the electrons result in ATP formation. Both ATP and $TPNH_2$ are utilized in the reduction of CO_2 to synthesize carbohydrates.

Since genetic differences result in differences in physiological processes, the assaying of inbred (genetically stable) lines will give a measure of gene action and by assaying hybrids, a physiological basis for hybrid vigor may be asessed.

The IBM 7090 will be used to calculate specific activity of chloroplasts, given as moles $K_3Fe(CN)_6$ reduced /mg chlorophyll/hour, from observations, taken as optical density figures, on the Bechman Model DU Spectrophotometer.

408-35030 Chemistry and Chemical Engineering. Ferrous Fluoride Spectrum. The object of this research is the straight-forward solution of secular equations.

409-35031 Civil Engineering. P-Wave Stresses in A Spherical Cavity. The problem is to determine the stresses at the surface of a spherical cavity due to a passing longitudinal elastic stress wave in an infinite medium. The problem is solved by expanding the disturbance due to the hole in the form of diverging spherical harmonics and the coefficients of the harmonics are determined from the condition of zero stress at the cavity surface. The boundary conditions give a separate pair of differential equations for determining the coefficients $f(r-ct)$ for each harmonic. The equations are solved by numerical integration beginning with known zero values when the wave hits the cavity.

Finally, the stresses are calculated from the contributions from each harmonic mode.

410-35032 Agricultural Economics. Work Study Regression. The problem is to determine the influence of herd size, number of milking machines used, degree of mechanization, type of building etc. on the labor requirement in milk production. The model used is a normal regression model with 15 independent variables. Since some of the variables are not quantitative, systems with dummy variables are used, indicating if a given attribute is present or not. In order to solve this equation in which several classes with dummy variables appear, one dummy variable from each class has been deleted.

The data are obtained from a mail-in survey among 164 Swedish dairy farms.

411-35033T Mechanical Engineering. Particle Distribution in Suspension Flow. The problem concerns the study of particle dynamics in turbulent flow of a solid-gas suspension flow. The first part of the study involves a theoretical prediction of the particle concentration distribution across the flow channel under a steady external field, starting from the fundamental equations of continuity and momentum. The equations form a system of first order nonlinear differential equations which can be solved by the Runga-Kutta method. The effect of different flow parameters and the contribution of various terms in the theoretical model need to be investigated.

412-35034 Graduate School of Business Administration. Business Programming. The School of Business Administration needs a short, simple linear programming routine for the students in the production courses. The routine will be about 100 Fortran cards and will be used in place of LP-90 (Library linear program) which requires relinquish time.

The solution will be reached using the simplex technique.

413-35035 Chemistry and Chemical Engineering. Chemistry Teaching Assistant Program. It is desired to prepare a teaching assistant program which will be used to assign quiz and lab sections of chemistry courses to teaching assistants in accordance with the number of contact teaching hours required for each assistant, and also in accordance with a coded rating of both courses and assistants.

Three divisions of assignments are involved. These are: total compatibility of a full section with an assistant (from point of view of hours available to teach), "2/3" compatibility = total number of quiz hours and majority of the lab hours in a given course section, and "1/3" compatibility = total number of quiz hours plus the smaller portion of the associated lab hours. The remaining parts of sections are then manually assigned to assistants, based on compatibility of course and teaching assistant ratings, as well as available hours.

414-35036 Agricultural Economics. Interregional Analysis of the Soybean Sector. The study involves an interregional analysis of the soybean sector of the U. S. economy within the conceptional framework of spatial price, equilibrium analysis. This type of analysis requires data relating to regional supplies and transportation costs and either single valued estimates or demand relations for estimating regional demands. Given the regional supplies and transport costs and either single valued regional demand estimates or demand relations the linear programming transportation model will be used to estimate the optimum geographical flows and price differentials.

415-35037 Agronomy. Course and Teacher Rating Forms Summary. The Course and Teacher Rating Forms are a summary of the student's opinion of a course, the teacher instructing the course, of the textbook or references used in the course, and of the laboratory instructor (if applicable) for the course. The student also rates himself in relation to the course.

As of this date, the rating forms will be distributed to all courses taught in the Agronomy Department. The summary of these forms will enable the instructor to find out the weaknesses of a course he is teaching, and of himself as the instructor of the course.

A program will be developed in Fortran to provide a summary of the forms for a given course, a number of courses, a given laboratory section, and a number of laboratory sections.

416-35038T Mathematics. Opsearch Computer Methods. The purpose of this problem is to develop general computer methods for several algorithms that occur rather frequently in several areas of operations research -- especially game theory, dynamic programming, and symbolic logic. The major work on this problem involves, of course, pencil and paper mathematics -- the 7090 will be used mainly for timing and accuracy checks. The work will be begun at an IBM datacenter this summer and will be developed into an undergraduate thesis by the prime user.

One of the major areas will be an attempt to abstract systems involving cardinal utility theory.

417-35039 Electrical Engineering. Antenna Characteristics in Magneto-Ionic Medium. The purpose of this project is to study the characteristics of a radiating element immersed in a magneto-ionic medium. It is planned to study both the far field and the near field characteristics of different kinds of antennas as a function of frequency and the parameters of the medium.

The Green's function for a current-element in an anisotropic magneto-ionic medium has been derived theoretically. Numerical calculations will now be performed to obtain the far field by integrating the Green's function for several different types of current distributions. The behavior of the far-field pattern will be studied as a function of the parameters of the dielectric tensor. The line integral $\int \bar{E} \cdot \bar{J} \cdot d\bar{l}$, where $\bar{E}$ is the electric field produced by the current element and $\bar{J}$ is the distribution of the current source, will be computed for different types of loop antennas. The numerical computations involve the following general operations: solution of a quadratic equation for various parameters; tracking the roots of a transcendental equation involving trigonometric functions; using these in the far-field expressions; and numerical integration of field expressions involving line and surface integrals.

Instructional Problem Specifications

During the month of May, 1 instructional problem specification was submitted for the IBM 7090.

I65-35019 Mathematics 195. Problem 5. Simultaneous Eq. by Gauss Elimination. Write and code check a Fortran program to solve a set of N simultaneous equations by the method of Gauss elimination. Do the calculation two ways:

(1) by taking the diagonal elements as pivots.

(2) by interchanging rows to get the largest element on the diagonal as pivot.

Assume $N \leq 9$ for the purpose of DIMENSION statements.

The equations are:

$$A_{11}X_1 + A_{12}X_2 + \dots + A_{1N}X_N = B_1$$

$$A_{21}X_1 + A_{22}X_2 + \dots + A_{2N}X_N = B_2$$

$$\dots$$

$$A_{N1}X_1 + A_{N2}X_2 + \dots + A_{NN}X_N = B_N$$

Information on the utilization and reliability of the IBM 1401 and IBM 7090 for the month of May 1963 is given in the tables below.

TABLE I - IBM 1401

Summary of Use

May 1963

Scheduled engineering	2:00
Unscheduled engineering	38:41
Maintenance	5:18
7090 preparation	418:15
Tape labeling	:30
Deck reproduction	2:27
Deck listing	16:49
Code checking	6:42
Tape testing	15:51
CDC preparation	:10
Tape copying	1:09
Tape dumping	17:55
Idle	25:06
	550:53

TABLE II - IBM 1401

Summary of Machine Errors

May 1963

Program	2
1401 processing unit	6
1402 reader punch	2
1403 printer	7
729V tape units	2
	19

TABLE III - MAY 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAINTENANCE	IDLE	TOTAL TIME	FAILURES	IBM 1401 DAILY TIME DISTRIBUTION
5/1/63	16:32		1:20	:10	2:08	20:10	1	(1) Binary trouble.
5/2/63	17:25		5:05	:23	1:07	24:00	2	(1) Binary trouble. (2) Continuous reader stops. Engineer had set 1401 at 850 and had forgotten to reset it.
5/3/63	23:15		:15	:10	:20	24:00	1	(1) Tape #98 broke near front coming out of rewind on tape unit A.
5/4/63	7:56					7:56		
5/6/63	14:47			:10	1:03	16:00		
5/7/63	20:05				3:55	24:00		
5/8/63	22:12		:10		1:38	24:00	1	(1) Tape Unit A does not function properly. Faulty capstan was found to be the trouble and was replaced. Also, oil reservoir in 1403 printer was filled with oil.
5/9/63	21:40			:05	2:15	24:00		
5/10/63	10:52		11:11		1:57	24:00	1	(1) Many process errors. Clearing storage does not get rid of them. Engineers called but could not locate trouble. Adjusted the voltage so that the 1401 would be able to run over the weekend.
5/11/63	18:10					18:10		The 1401 is running with a one volt increase to keep it from failing.
5/13/63	11:10		4:40	:10		16:00	2	(1) Same trouble as above. (2) Fuse blown on 1402 and replaced.
5/14/63	22:15		1:25	:20		24:00	1	(1) Same trouble as above.
5/15/63	24:00					24:00		
5/16/63	20:05		3:55			24:00	1	(1) Many process errors. Engineers changed 1 level of a card. Voltages were reset higher which corrected the trouble.
5/17/63	21:00		2:45	:15		24:00	2	(1) 1403 trying to write a line, but carriage will not space. Trouble found to be broken valve stem which was replaced. (2) Valve stem bolt not tightened and 1403 doing continuous ejects.
5/18/63	8:37					8:37		
5/20/63	16:00					16:00	1	(1) Process error at the end of every job that is printed. Trouble not found.
5/21/63	20:15			1:05	2:40	24:00		
[illegible]	[illegible]			:40	1:00	24:00	1	(1) 1403 printer skips a page randomly.

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAINTE-NANCE	IDLE	TOTAL TIME	FAILURES	IBM 1401 DAILY TIME DISTRIBUTION
5/23/63	18:30	2:00	3:20	:10		24:00	1	(1) Corrected page eject on 1403 printer and removed power booster. Installed carriage restore switch on rear of 1403 printer.
5/24/63	23:20			:25	:15	24:00		
5/25/63	11:50			:20	:50	13:00		
5/26/63	4:45			:15		5:00	1	(1) High velocity page ejects on printer occurring randomly.
5/27/63	20:30			:10	:50	21:30	2	(1) Same as above. (2) Excessive sum checks on 1403.
5/28/63	20:12			:15	3:33	24:00		
5/29/63	19:25		4:35			24:00	1	(1) Lost all power to 1401. Power came back up when engineer arrived, but unusual process errors occurred. Current driver and current source card found to be the trouble, and replaced.
5/30/63	6:55				1:35	8:30		
5/31/63	15:45			:15		16:00		
	479:48	2:00	38:41	5:18	25:06	550:53	19	

TABLE I - IBM 7090

SUMMARY OF USE

MAY 1963

Scheduled engineering	37:06
Unscheduled engineering	8:18
Air conditioning	:30
System updating	2:39
Production (see Table IV)	518:56
Operator manipulations (tape changing, cleaning, etc.)	97:43
	665:12

TABLE II - IBM 7090

SUMMARY OF MACHINE ERRORS

MAY 1963

Arithmetic Unit	3
729VI Tape Units	11
711 Reader	2
721 Punch	2
Multiplexor	1
Data Channel A	4
Data Channel B	2
Direct Data Channel	1
Air Conditioning	1
	27

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	TAPE HANDLING TIME	TOTAL RUNNING TIME	FAILURES	IBM 7090 DAILY TIME DISTRIBUTION
5/12/63	15:00					15:00		
5/13/63	20:56	2:00	1:15			24:11*	2	(1) Tape unit U taken off-line. (2) Tape unit U tested and put back on-line after replacing prolays.
5/14/63	17:51	2:00			4:09	24:00		
5/15/63	10:52	3:15			9:53	24:00		
5/16/63	13:54				10:06	24:00	1	(1) 721 Punch generates machine error everytime a card is punched. Disconnecting the external signal interrupt line from the computer stops the errors.
5/17/63	16:04	1:00	:40		6:16	24:00	1	(1) Direct data interrupt circuit changed.
5/18/63	5:06				3:09	8:15		
5/19/63	3:08					3:08		
5/20/63	17:05	1:50			:35	19:30	1	(1) Tape unit S giving continuous errors.
5/21/63	18:49	1:40			3:31	24:00	1	(1) Tape unit S was lubricated and put back on-line.
5/22/63	18:08	1:37			4:15	24:00		
5/23/63	17:35	2:36	:05		3:44	24:00	1	(1) Tape unit Y lost vacuum in right vacuum column. Dirty switch contact found.
5/24/63	17:49	1:20			4:51	24:00	1	(1) Many tape errors on Channel B. Suspect machine causing them.
5/25/63	18:01		1:35		4:24	24:00	1	(1) Many tape errors on Channel B. Engineers adjusted tape clipping level and trouble disappeared.
5/26/63	21:56				2:04	24:00		
5/27/63	22:22	1:46				24:08*		
5/28/63	19:26	1:20			3:14	24:00	1	(1) 06105 halt which is a machine error in 721 punch.
5/29/63	22:28	1:00	:30		:02	24:00	1	(1) Suspected trouble with computer when strange halts occurred during Fortran translation, but when tape units were switched around, trouble disappeared.
5/30/63	20:45				3:15	24:00		
5/31/63	25:40	1:25				27:05*		
	521:35	37:06	8:18	:30	97:43	665:12*	27	

* Due to the fact the system updating took place at 0800 these figures reflect running over 24 hours on some days.

TABLE III - MAY 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	TAPE HANDLING TIME	TOTAL RUNNING TIME	FAILURES	IBM - 7090 DAILY TIME DISTRIBUTION
5/1/63	19:24				4:36	24:00	1	(1) Printer and tape units 2 and 4 were all selected at the same time. Trouble disappeared.
5/2/63	17:44	2:10			4:06	24:00	3	(1) 711 reader causing errors. Trouble disappeared on second attempt. (2) Tape unit R will not rewind. Trouble found to be stuck relay. (3) Punch motor will not turn off - punch functions normally otherwise. Later, trouble disappeared and punch turned off.
5/3/63 5/4/63 5/5/63	17:22 23:44 1:45	1:55			4:43 :16	24:00 24:00 1:45	1	(1) Tape unit U giving errors in reading System Tape I. Moved to unit Ø and worked all right. Engineers not called.
5/6/63	13:53	2:00	:46		3:01	19:40	3	(1) Tape unit X jammed. Trouble found to be sticky capstan. (2) Tape units on Channel A will not rewind. Trouble disappeared. (3) 7090 in automatic but would not operate unless set to manual. Trouble then disappeared.
5/7/63	19:39	1:50	:25		2:06	24:00	1	(1) Tape unit U taken off-line and inspected. Was put back on line to adjust transport which failed to adjust properly and then taken off line. Put back on line to adjust skew and had many failures during testing and taken off line.
5/8/63	16:34	2:17	:30		4:39	24:00	1	(1) Power check on multiplexor. Trouble disappeared. Tape unit U was put back on line after replacing defective prolay.
5/9/63	17:16	2:15	1:02		3:27	24:00	1	(1) Channel A lost response to rewind instruction. Trouble disappeared.
5/10/63	16:50	1:50	1:30	:30	3:20	24:00	2	(1) Channel A writes tape instead of rewinding. Bad card found and replaced in channel write clock. (2) CPR power check. Temperature was too hot to run.
5/11/63	14:29				4:01	18:30	3	(1) Many illegal halts at location 06105. Trouble not found. (2) Tape unit U failed to write tape

Department	Number of Runs				Number of Problem Specifications				Time Used			
	Classes	Research In System	Research Non System	Total No. of Runs	Classes	Research In System	Research Non System	Total No. of Prob. Specs.	Classes	Research In System	Research Non System	Total Time Used
Aeronautical and Astronautical Engineering	187	9		196	3	1		4	2:25	:27		2:52
Agricultural Engineering		44		44		3		3		:58		:58
Agricultural Economics		62	26	88		7	6	13		:28	9:58	10:26
Agronomy		111		111		10		10		2:07		2:07
Animal Science		2		2		1		1		:05		:05
Architecture		69		69		1		1		1:14		1:14
Astronomy		25		25		4		4		:16		:16
Bureau of Community Planning		3		3		1		1		:18		:18
Civil Engineering	862	965		1827	6	34		40	12:08	26:48		38:56
Chemistry and Chemical Engineering		899		899		32		32		23:52		23:52
Communications		44		44		2		2		:24		:24
Digital Computer Laboratory	362	684	69	1115	2	19	6	27	4:59	14:28	236:38	256:05
Dairy Science		28		28		1		1		:37		:37
Economics		6		6		1		1		:09		:09
Education		30		30		5		5		3:22		3:22
Electrical Engineering	688	386		1074	8	14		22	9:33	7:53		17:26
Forestry		6		6		1		1		:20		:20
General Engineering		2		2		1		1		:05		:05
Geology		5		5		1		1		:06		:06
Graduate School of Business Administration		2		2		1		1		:01		:01
Institute of Communications Research		83		83		4		4		1:46		1:46
Industrial Engineering	14	44		58	1	1		2	:10	:54		1:04
Industrial Education		9		9		2		2		:34		:34
Institute of Government and Public Affairs		12		12		1		1		:16		:16
Instructional TV		49		49		3		3		:57		:57
Institute for Research on Exceptional Children		5		5		1		1		:14		:14
Institute of Labor and Industrial Relations		6		6		1		1		:09		:09

TABLE IV - IBM 7090 (Continued)

Department	Number of Runs: Classes	Number of Runs: Research In System	Number of Runs: Research Non System	Number of Runs: Total No. of Runs	Number of Problem Specifications: Classes	Number of Problem Specifications: Research In System	Number of Problem Specifications: Research Non System	Number of Problem Specifications: Total No. of Prob. Specs.	Time Used: Classes	Time Used: Research In System	Time Used: Research Non System	Time Used: Total Time Used
Mathematics	4044	328		4372	4	7		11	36:11	4:09		40:20
Mechanical Engineering	259	331		590	1	19		20	2:50	15:55		18:45
Marketing		2		2		1		1		:04		:04
Mining, Metallurgy and Petroleum Engineering		69		69		3		3		1:46		1:46
Men's Residence Hall Association Rocket Club		100		100		1		1		1:39		1:39
Music		52		52		2		2		1:26		1:26
Natural History Survey		1		1		1		1		:01		:01
Nuclear Engineering	92	44		136	1	2		3	1:19	1:15		2:34
Office of Instructional Research		22		22		1		1		:41		:41
Physics	220	1023		1243	2	24		26	4:00	35:38		39:38
Physiology	7	1		8	1	1		2	:04	:05		:09
Plant Pathology		2		2		1		1		:02		:02
Psychology	2	328		330	1	23		24	:02	13:07		13:09
State Geological Survey		5		5		1		1		:16		:16
Small Homes Council, Bureau of Residential Construction		10		10		1		1		:19		:19
Sociology		55		55		1		1		1:17		1:17
Statistical Services Unit		347		347		3		3		14:07		14:07
State Water Survey		89		89		7		7		5:47		5:47
Theoretical and Applied Mechanics	91	372	1	464	1	12	1	14	:52	9:29	1:00	11:21
Sub Total	6828	6771	96	13695	31	264	13	308	74:33	195:51	247:36	518:00
Instruction		65		65		1		1		:56		:56
Grand Total	6828	6836	96	13760	31	265	13	309	74:33	196:47	247:36	518:56

PART VII

GENERAL LABORATORY INFORMATION

Colloquia

"The Application of Real Time Computing to Machine Tool Control Systems," by Mr. Conrad J. Isak, Manager, Program Control Development Engineering Unit, Specialty Control Department, General Electric Company, Waynesboro, Virginia, May 6, 1963

"COGENT--A Compiler and Generalized Translator," by Dr. John C. Reynolds, Applied Mathematics Division, Argonne National Laboratory, Argonne, Illinois, May 13, 1963

"Tree-Organized Memory and Its Use in Dynamic Storage Allocation," by Dr. Anatol W. Holt, Applied Data Research, Inc., Princeton, New Jersey, May 27, 1963

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	15	1	15.5
Visiting Faculty	3	0	3.0
Research Associates	4	0	4.0
Graduate Research Assistants	6	35	23.5
Graduate Teaching Assistants	0	4	2.0
Research Engineer	1	0	1.0
Administrative and Clerical	8	0	8.0
Other Nonacademic Personnel	43	65	66.5
TOTAL	80	105	123.5

The Computer Advisory Committee consists of Professors H. C. Brearley, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During May a total of 111 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	1	0
Medium Drawings	9	0
Small Drawings	0	0
Reports	32	10
Change Orders	1	0
Printed Circuits	0	3
Miscellaneous	55	0
TOTAL	98	13

(E. Corso, K. C. Law)

Shugaia

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

JUNE 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction

In terms of transistor counts the following progress has been made during June.

Chassis dc checked	0
Chassis inspected	184
Chassis wired	184
Chassis in wiring	968
Chassis laid out	92
Printed Circuits (446 boards wired)	2,194

(T. Kerkering, F. Serio)

A new system of record keeping for printed-circuit cards has been instituted.

(D. Chow, F. Serio)

2. Component Testing

Basic drawings for a new transistor tester has been completed. The design will allow standard tests on many transistor types to be done with a minimum of set-up effort.

Transistors were tested in QRM#8, A#4 and S#1. Approximately one per cent of the transistors were found to have deteriorated more than a trivial amount. A report is in preparation.

Detailed data was taken on 15 assorted transistors. Acceptance tests were run on about 3,100 transistors and 1,650 diodes.

(B. Doden)

3. Status of Interplay

The bulk of Interplay has been built and checked out. There is enough operational hardware to allow 16 of the 32 channels (including Drum channel) to function.

The remaining channels can be added by merely completing fabrication of four 12 x 18 chassis and two 8 x 12 chassis for which the main frame is already wired and checked out.

A breakdown of the chassis-function relation is as follows:

Priority Circuitry and Address-List Word Drive

CC5
CD5
CE5
CD6*
CE6*

Interplay Order Distributor

CDL	CD1C
CE1	CE1C
CD2	CD2L
CE2	CE2L
CD3*	CD3L°
CE3*	CE3L°

Drum Channel Control

CD17
CD18
CD19
CD20
CD16L

Drum Buffer Registers and sWOB Selector Word Output to Interplay Channels 1-31

CE17
CE18
CE19
CE20

SMWB Selector Word to Core Memory

CL15
CD15
CD16

Interplay Control

CE7
CE8
CE9
CE10

Interplay Address Register and Address-List Digit-Drive

CL6
CD6

Interplay Address-List Core Memory and Sense Amplifier

CC5

sCA Address to Core Memory

CC16

AC Drum Interplay[†] Interlock

CC14-3

12 x 18 chassis needed *
8 x 12 chassis needed °

(S. P. Krabbe)

† 31 Interplay channels.

4. Magnetic Drum Memory

Magnetic drum serial number 128 is at the manufacturer's plant for overhaul in an attempt to eliminate the squeak that sometimes occurs within the first five minutes after turn-on. When it was disassembled, the manufacturer found no bearing damage or other likely causes. However, they did report an accumulation of oily dust inside the housing. The other drum (serial number 129) has air filters which operate even when the cover is open for adjusting heads, and it has not been operated as many hours with the covers open.

Two accidents occurred with drum 129 on June 7. While setting the heads on column Ø, head Ø 10 scraped the track. The shim was still in place; the reason for the accident is not known. An hour and a half later, while no adjustments were being made, there was a screech. Heads N 10, Ø 10, P 10, and A 11 were removed for inspection. Head and track P 10 had been completely destroyed. The oxide was gone across the whole 0.31-inch width of the head barrel and the whole head face was scarred aluminum. Head Ø 10 was damaged slightly, probably only by the earlier accident. Heads N 10 and A 11 were undamaged, but their tracks were gone.

The cause of the second accident is not known. It is suspected that (1) debris from the earlier Ø 10 accident lodged under head P 10, which is two inches downstream and .050 inches offset from head Ø 10, (2) a gust of cool air from the air conditioning inlets below the drum caused the housing to contract slightly, causing head P 10 to touch its track and (3) the frictional heat expanded the barrel of head P 10, driving it further into the oxide and aluminum. Another explanation is to omit step (2) and conjecture that the offending debris remained stuck to head Ø 10 for the intervening hour and a half, and then blew under head P 10 to cause step (3). Drum 129 has since been successfully operated with the damaged heads retracted. Current policy is to block all the air conditioning ducts in the drum memory at the floor level before removing the drum covers.

The logic chassis of the drum memory have been constructed and in use for some time. The remaining construction work consists of building the seven read-write chassis (two bits per chassis). First a prototype 1-bit chassis was built. Then the peak detector was redesigned, other changes were made, and two full chassis, serial numbers 2 and 3, were built. Both the prototype and number 2 have been operated successfully. The mechanical problems associated with 256 head wires, potentiometer mounting, and power supply filtering have been solved.

Magnetic crosstalk was measured. When the read amplifier was delivering 5.8 volts peak-to-peak at 280 bits per inch and 11.0 volts peak-to-peak at 35 bits per inch, the worst crosstalk found was 0.6 volts peak-to-peak or ten per cent. Electrical crosstalk through the capacitances of the matrix diodes is unmeasurable. The residual signal at 35 bpi observed when writing 280 bpi over 35 bpi is 0.5 volt peak-to-peak or nine per cent.

The drum memory was tested on-line using a program written by G. E. Cooper. Some of the transfers were successful and some wiring errors were found. Only simple patterns were used; more complex patterns will be used later.

(H. C. Brearley, M. D. Freedman)

5. Core Memory

The core memory has been operating very well since the +65 supply voltage was reduced to +45 volts. Although the precise reasons for this improvement have not been carefully analyzed, it appears to be partially explainable as a reduction of the noise caused by the inductance of magnetic switch input circuits. The lower voltage (+45 v) allows read drivers to saturate, thus damping the oscillatory tendencies of these high-inductance lines. If allowed to oscillate, a noise component is coupled to the sense signal.

With regard to the number of parity errors indicated in the tabulations in this document (namely four errors), it should be noted that no parity errors have occurred since June 11 which was the date that the above power supply adjustments were finished.

(S. Ray)

6. Exponent Arithmetic Unit

In view of its limiting effect on Arithmetic Unit speed it has long been felt that the Exponent Arithmetic Unit should be examined minutely for questionable circuits. A marginal voltage check recently revealed a fault in this area and again shows this unit to be a very critical one in its present

state. It was demonstrated that small speed changes induced by current probing were sufficient to cause failures over a wide area, including the related part of Flow Gating.

The particular offending component was found to be a partially shorted emitter follower in the ES_0 output to flow gating; however, the impressions remains that a much more thorough check of the area should be made.

(H. Lopeman, K. Smith)

7. Special Register Distribution Point (SRDP)

The Special Register System has been installed with the 1401 Channel as a first user. A reader-punch special register will be installed in the near future. Presently the old reader-punch circuitry exists as a switchable alternative to SRDP operation.

(H. Lopeman, R. Kingsley, R. Willard)

8. A Review of Speed-up of Delayed Control

Detailed measurements of individual operation times and program running times were made with the machine in the various stages of speed-up that have prevailed since September, 1962. The effect of core memory cycle time in the range 1.6 to 2.2 μsec was simultaneously evaluated.

The data has been interpreted and a brief description of the rationale and procedure of speed-up has been written (File No. 555).

(R. Kingsley, R. Shively)

9. Interrupt

Layout of chassis B8F has been done and sent to the shop. Associated card racks have been layed out and wiring started.

Change orders to modify the AC decoder to expand the class of protected orders and to facilitate Interrupt were issued. The chart which

defines AC decoder signals and explains their significance was expanded and updated.

(M. Faiman, H. Lopeman, R. Shively)

10. Block Checker

The chassis B9R, B10R and B11R were installed and are believed operational although further dynamic testing must be performed.

(R. Kingsley, R. Shively)

11. IBM 1401 Interplay Channel

ICC7, the 1401 channel control has been checked out (except some begin and end conditions) using the device simulator.

The ICC7 1401 interface has been checked out to the extent that block transfers can be made between the 1401 and core memory. There are still some begin and end conditions that have not been checked.

Checkout of special registers SR24 and SR29 and associated logic was started the last part of this month.

(J. Bouknight, S. P. Krabbe, R. Miller)

12. IBM 1414 Interplay Channel Design

The logic for the 1414 Interface has been generated, except for circuits to accomplish a few isolated operations such as SKIP, and detection of timing errors. The checking of the logic has commenced.

(M. J. Pisterzi)

13. Test Console Interplay Channel

ICC NOR logic has been modified for channel 16. The indicators were completely rearranged in a more desirable way. There will be no G/H element

flipflops in the word counter which will consist only of NOR circuits and gate drivers.

In order to contain all pallet boards from the Main Frame and the test console, rack a will be redesigned to contain 42 pallet boards.

A complete description of the interface between ICC and channel 16 boards will be contained in a forthcoming report (File No. 552).

(Y. T. Yen)

14. Engineering Programming

In June the parity bit oscillate test (Pl-PBO-46v) was rewritten in two alternate forms with a null order (CAM 0,0 or CAM 2,0) inserted into each word so as to make each program word have the same parity. These two forms are called PB-odd and PB-even.

A memory test based on certain order combinations used by D. B. Gillies in the Mersenne prime number routine was written and code checked in fixed locations. This test (Mersenne Memory Test) consists of the following two routines.

1) With two lists of n words, clear add word (k_1) and multiply by word $(n - k_2)$ where k_i is the kth word of the ith list. In this case, both lists were the same and the check was performed by comparing the word stored in memory after multiplying (k_1) by $(n - k_2)$ and $(n - k_1)$ by (k_2).
2) Perform an end around shift of a list of n words. Repeat this n times and check to see if the results compare with the initial conditions.

Work was begun to prepare the Mersenne Memory Test as a self-contained relocatable, leap-frog type program capable of checking the entire memory.

(M. Levin)

PART II

ILLIAC II SYSTEMS PROGRAMMING AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Meetings

A weekly seminar at which members of the programming group describe their work has been instituted. Presentations this month were made by

H. Jarosch -- NICAP

J. Aaron -- Interrupt and I/O Processing System

Weekly meetings of a group who will discuss the Algol compiler have begun. Both of the meetings are open to interested persons.

(C. W. Gear)

2. Assembly Program

NICAP has been tested for one set of test data through all three passes using paper tape simulation. Work is now being concentrated on checking out the routines which communicate with the 1401 for input/output and for use as back-up store.

(H. Jarosch)

3. Subroutine Library

The computation section of the Inverse Laplace Transform routine has been code checked. The data organization and checking section is being coded.

(E. Brower)

Work is continuing on a trace routine. Checkout will begin shortly.

(F. Schaffer)

Work is continuing on the Variable Format Input/Output with Conversion program for the ILLIAC II. This program is similar to the 7090 system .READ|.PRINT|.PUNCH program.

(M. Gaer)

4. Computer Use

Engineering and Maintenance		149:44
Interplay Engineering		111:09
Drum Engineering Using ILLIAC II		5:37
Engineering Routines		
EST	31:00	
Duplex Memory	:55	
OLF	1:10	
Memory Reversing	18:03	
Cross-talk	3:12	
D.A.M.N.	19:31	
		73:51
Code Checking		56:44
Demonstrations		:57
Production		
Mersenne Primes (Gillies)	135:54	
Fosdick-Jordan	131:04	
		266:58
Idle		21:05
TOTAL TIME		686:05

Detected Errors

Reader	8
Punch	4
Parity	4
Power Failures	1
Unknown	2
TOTAL ERRORS	19

Component Failures

Transistors		
Induced by Accident	2	
Spontaneous Failure	9	
Induced by Other Failure	4	
		15
Zeners		
Spontaneous Failure		2
Diodes		
Induced by Other Failures		11
TOTAL COMPONENT FAILURES		28

(W. L. Huffman)

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Gabor Ujhelyi and Sergio Ribeiro have built and tested several light modulators. A full report will be published as soon as the results have been coordinated.

Henry Guckel has started to work on the systems aspects of his tunnel-diode-transmission-line amplifiers. He has designed a termination link which will allow him to join together lines of arbitrary length by active sections. He is also considering systems in which the active elements themselves are distributed along a transmission line.

Louis van Biljon has reworked his theory of the avalanche effect by taking account of parasitic resistances between the transistor terminals. It seems to be nearly impossible to determine values of these resistances which are attained asymptotically every time the transistor is "baked" for a given period of time. It also appears that capacitive effects will have to be taken into account in the measurement of characteristics.

2. Tunnel Diode Work

The major part of this month has been spent in the preparation of a report which summarizes the distributed circuit work up to this point. This work has now been completed.

Further work was done on distributed coupled structures. An investigation of the effect of tolerances on the ideal model indicates that at half-wave multiples of the equivalent electrical length of the transformer, large reflections occur. However, since a short intercoupled structure is desirable, this effect will not be felt at the high-frequency end of the spectrum if the electrical length is made short enough so that the cutoff frequency of the diode is below the half-wave resonance. This implies that the tolerances affect the low-frequency end only. However, since the minimum transmission line length is

not determined only by the physical size of its conductors, but also from the magnitude of expected end effects, the interconnections to the load must be improved. Studies of this aspect are in progress and partial results have been achieved. It is currently contemplated to use the method shown in Fig. 1.

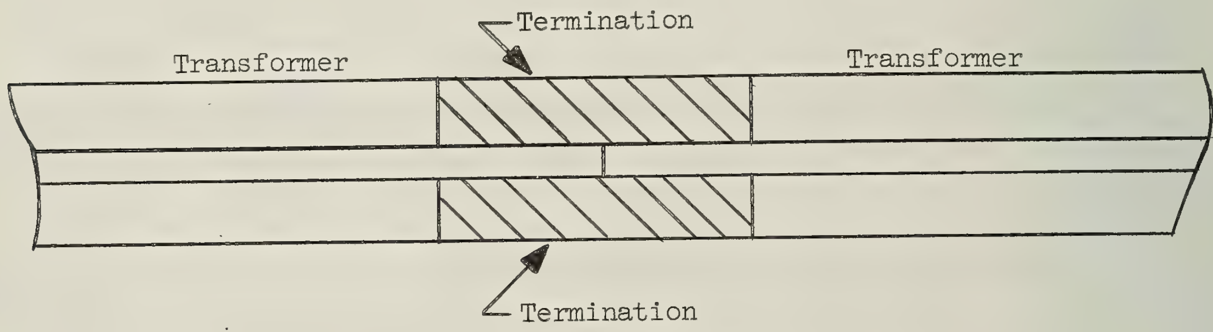


Figure 1. Joint between Transmission Lines

The termination containing the Goto pair is currently under construction. The power supply bleeder resistors are buried in the board; the diodes are mounted through the board. The result is that the entire circuit is contained in a 1/16-inch board.

Theoretical investigations of two distributed tunnel diodes were started. A possible layout is shown in Fig. 2.

Figure 2. Distributed Structures

The establishing of the two junctions seems to be possible. However, since bulk material is connected to both sides of the junction an extremely lossy transmission line results. Skin effects must therefore be taken account of. The series impedances are then nonlinear with respect to frequency. In order to avoid this, the investigation was shifted to tunnel-hot electron structures.

3. Avalanche Effect in Transistors

Particular attention was paid to the I_{CO} - V_{CB} curve to establish why the multiplication factor M, as found from this curve deviates so far from Miller's M_M found in diodes.

It was found that apart from leakage resistance, a current-aided field as well as base width modulation could be responsible for most of the departure from M_M as observed.

From conventional analysis the electric field in the base of a transistor may be determined in terms of the total current density, $(J_n + J_p)$, as:

$$\underset{\sim}{E} = \frac{MJ_p + qD_p \frac{\partial p}{\partial x}\left(1 - \frac{\mu_n}{\mu_p}\right)}{q\mu_p\left[2p + N_d \frac{\mu_n}{\mu_p}\right]} \tag{1}$$

In the above it is assumed that

$$J_n = (M - 1)J_p$$

so that electron current arises solely as a result of pair formation during multiplication.

The field $\underset{\sim}{E}$ may be expressed in terms of the total current density as well as the resistivity of the base material, so that

$$\underset{\sim}{E} = MJ_p\rho$$

Also from conventional analysis the hole gradient may be found as

$$\frac{\partial p}{\partial x} = \frac{p_n}{2} \frac{\epsilon^-}{e^{-\frac{w}{2}\epsilon^-} - 1} e^{\frac{x}{2}\epsilon^-} \tag{2}$$

$$\epsilon^- = \frac{q\underset{\sim}{E}}{kT} - \sqrt{\left(\frac{q\underset{\sim}{E}}{kT}\right)^2 - \frac{4}{D\tau}}$$

From (1) and (2) we deduce that

$$J_p = \frac{F(\underset{\sim}{E})}{MK_1} \tag{3}$$

where

$$F(\underset{\sim}{E}) = \frac{\epsilon^-}{e^{-\frac{w}{2}\epsilon^-} - 1}$$

and

$$K_1 = \left[\frac{\partial[qN_d\mu_n p - 1]}{D_p \cdot p_n(1 - \frac{\mu_n}{\mu_p})}\right]$$

M may now be found for germanium from curves published by McKay and McAfee (Phys. Rev. Vol. 91, Sept. 1953) and F(E) may be determined from physical data of the transistors. However to compare experimental and theoretical results, it should be remembered that the current density measured is the total density, viz., MJ_p. For practical purposes (3) should thus be written as

$$(MJ_p) = K_2F(E) \qquad (K_2 = \frac{1}{K_1})$$

Noting that for a germanium structure the width of the depletion layer in an abrupt junction is

$$\text{Width} \simeq \sqrt{\rho V} \times 10^{-4} \text{ cm}$$

F(E) may be calculated as a function of base width w, and of $\underset{\sim}{E}$. Assuming an initial (low voltage) base width of 0.6×10^{-3} cm $F(\underset{\sim}{E})$ varies with voltage as shown in Fig. 3.

From the shape of this curve it is obvious that base width modulation could have a strong influence upon that I_{CO} curve and most probably accounts for a large part of the descrepancy between M_M and M found from

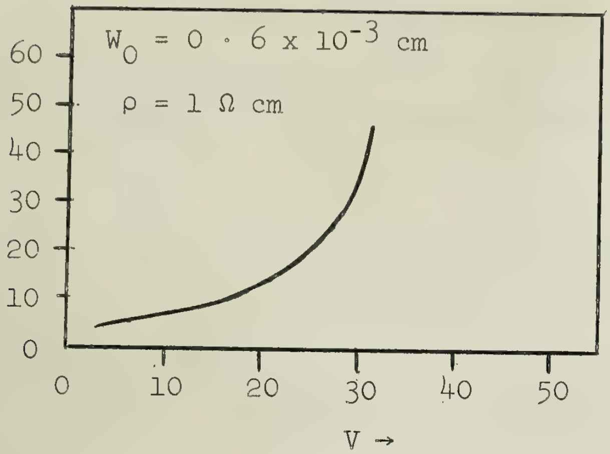


Figure 3. Variation of F(E) with Voltage

$$M = \frac{I_{CO}}{I_{COO}}$$

Another point investigated experimentally is that of long time constant effects associated with the V - I characteristic of the base-collector junction. Figure 4 shows some of the results obtained on a 2N650 transistor at 40°C.

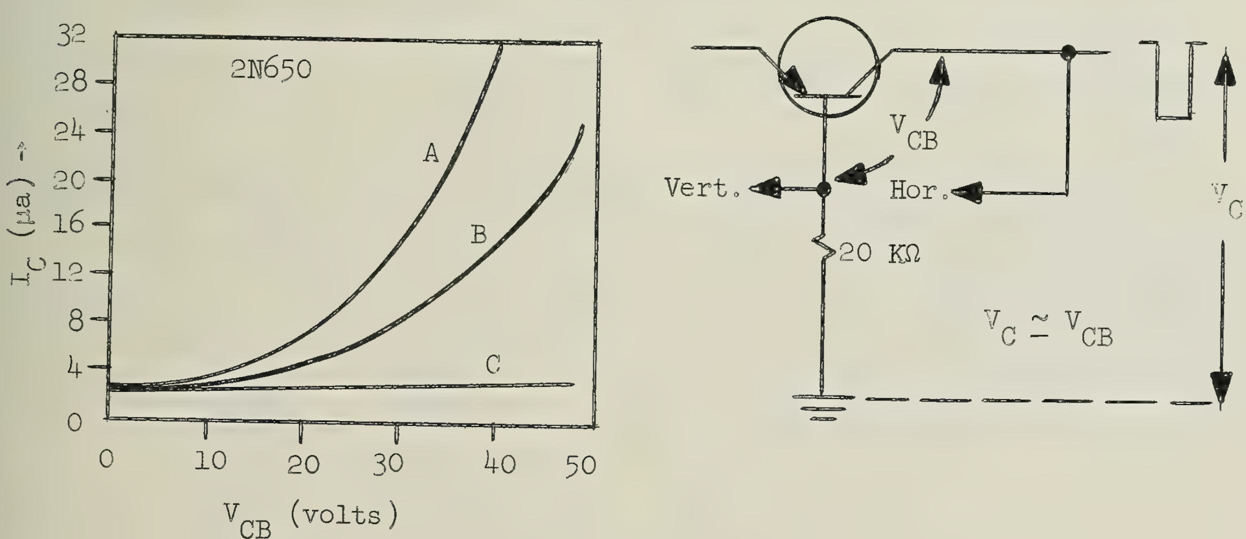


Figure 4. Time Effects

Curve A shows the characteristic obtained with single shot V_{CB} excitation; a single 100 μsec pulse was applied and then one minute was allowed to elapse before applying the next 100 μsec pulse at a slightly higher voltage. Curve B represents the path traced out by 100 μsec pulses applied every 5 milliseconds and 10 secs allows at each voltage before taking of reading.

The lowest curve represents the dc case, with 30 seconds allowed at each value of voltage before taking a reading.

The actual current decay observed after application of a dc voltage is shown in Fig. 5. The voltage applied was about 40 volts.

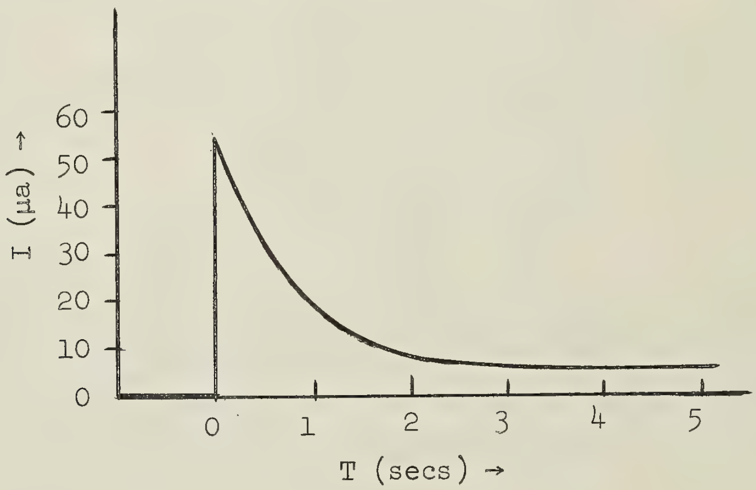


Figure 5. Time Delay

Time constants of the length shown above make the determination of avalanche data very difficult indeed. At near avalanche voltages, the dissipation is normally so high that thermal effects influence observed characteristics under dc conditions. Pulsed observations however suffer due to the long time constants; as long as the limitations are kept in mind it is thought that pulsed observations will yield useful data on avalanche phenomena.

PART IV

SWITCHING THEORY

(Supported in part by the Office of Naval Research under Contract Nonr-1834(27).)

Mr. Clinton R. Foulk has completed his doctoral thesis on multi-dimensional cyclic spot-error-correcting codes for information transmission and storage. The following is an abstract of his thesis.

"Let C be a binary cyclic group code correcting a set of errors D, and suppose that the coordinates of each code word in C and each error in D are mapped systematically onto the points of a regular geometric array, or raster, in N-dimensional Euclidean space. Then we may define a spot-error of diameter d as an error u in D such that no two nonzero coordinates of u are farther than distance d apart. It is easily seen that the problem of constructing a cyclic spot-error-correcting code of diameter d on a given raster is a direct generalization to N dimensions of the problem of constructing a cyclic burst-error-correcting code on a one-dimensional raster, or line. We present three methods for finding the generating polynomial of a cyclic spot-error-correcting code of given diameter on a given raster.

"The first method presented is the Direct Method, in which all polynomials with coefficients in GF(2) are examined in order of increasing degree to determine whether or not they generate a given code. Tables are included summarizing the results of computer searches for polynomials which generate 1) maximally efficient cyclic burst-error-correcting codes of diameters 1 through 5 on a one-dimensional raster, 2) cyclic spot-error-correcting codes of diameters 1, $\sqrt{2}$, and 2 on a square two-dimensional raster, 3) cyclic spot-error-correcting codes of diameter 1 on a hexagonal two-dimensional raster, and 4) cyclic spot-error-correcting codes of diameter 1 on a square three-dimensional raster.

"The second method presented is the Fire Method, which is a generalization to N dimensions of the method discovered by P. Fire for constructing a one-dimensional burst-error-correcting code by finding a polynomial of the form $P(t) = (t^{n_2} + 1)P_1(t)$, where n_2 and $P_1(t)$ are chosen to satisfy certain conditions with respect to the errors to be corrected.

"The third method presented is the Combination Method, which combines the Direct Method with the Fire Method, thus enabling one to extend the

usefulness of results obtained by the Direct Method to the construction of codes on rasters of any desired size.

"Finally, the codes obtained by the methods described in this paper are compared with the iterated two-dimensional codes discovered by Elspas."

Mr. Foulk's thesis has been prepared as Laboratory Report No. 141.

PART V

MATHEMATICAL METHODS

(Supported in part by the National Science Foundation under grant G16489.)

Monte Carlo Methods in Quantum Statistics

1. The job of rewriting subroutines used in Wiener integral evaluations so that these routines may be used with programs assembled by the New Illinois Computer Assembly Program was begun in May 1963. The job has been continued during June and will be completed as soon as conventions for input and output operations are fixed by the NICAP group.

2. The program FJ-21 which is a minor modification of FJ-17 has been used along with FJ-17 to obtain the two particle Slater sum

$$W_2(r_{12}) = \sum_{\substack{\text{symmetric} \\ \text{states } \alpha}} e^{-\frac{E_\alpha}{kT}} |\psi_\alpha(\vec{r}_1, \vec{r}_2)|^2$$

as a function of $r_{12} = |\vec{r}_1 - \vec{r}_2|$ for two particles interacting by a Lennard Jones 6-12 potential. W_2 versus r_{12} has been obtained for temperatures $T = 5^\circ K, 10^\circ K, 20^\circ K, 50^\circ K, 300^\circ K$. This data will be used to calculate the second virial coefficient of helium for these temperatures.

PART VI

IBM 7094-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

Three new routines were added to the 7094 Library during the month of June.

B4-UOI-CUR3-38-SR — Floating Point Cube Root FØRTRAN, SCATRE, MAD. This routine computes the cube root of any normalized floating point number.

(D. Hutchinson)

D2-UOI-ADM3-36-SR — 4th Order Adams-Moulton Integrator. This routine integrates a set of N first order total differential equations, using an Adams-Moulton 4th order difference method.

(T. M. Latta)

F1-UOI-MAM2-37-SR — Double Precision Floating Point Matrix Multiplication FØRTRAN or SCAT (7094). This assembly language coded subroutine uses 7094 double-precision operations to compute the product of two real matrices. The factor matrices and the product matrix are stored in double-precision forms as two-dimensional floating-point FØRTRAN arrays (not as described in IBM distribution J28-6114-1, Double Precision and Complex Arithmetic, see RESTRICTIONS). The use of 7094 double precision orders makes this routine much faster than one which uses single precision orders to do double-precision arithmetic.

This is a modification of a program originally written for the IBM 704 by Phillip Deuel, January 22, 1962, Computer Center, University of California, Berkeley, California.

(D. Hutchinson)

During the month of June, 23 problem specifications were submitted for the IBM 7090.

418-35043 Civil Engineering. Elastic-Plastic Stress Analysis. Given the closed-form solution for elastic stress distribution associated with hyberbolic and elliptical notches in plates, the program calculates the extent of yielding, based on the von Mises yield condition, for various input parameters.

The simple process of iteration is used to obtain the desired result. Only standard library routines, SIN, COS, ATAN, SQRT, are employed.

419-35044 Nuclear Engineering. Reactor Pulse. This code will be used to calculate neutron pulse velocities during pulsed operation of the University of Illinois TRIGA Reactor. The equations solved are standard time-dependent linear differential equations of the form familiar for time dependent heat conduction equations. A Green's function method is used, so integrations over the time distribution (and spatial distribution of the neutron slowing down density) are required. A standard finite difference method (along with numerical evaluation of the integrals) is used.

420-35045 Mechanical Engineering. General Solution of Chemical Equilibrium The solution of the family of non-linear equations by iteration will be programmed in a manner to make the inclusion or exclusion of compounds considered possible without the necessity of reprogramming each set separately.

421-35046 Education. High School Student Work Contacts. The immediate research problem involving the 7090 is one part of a description of the relational system among the students in a small midwestern high school. The problem segment involves analysis of observations of social contacts of students during study halls. The analytic procedure involves the addition of the number of contacts between each pair of students in the high school over eighty (80) observations of study hall periods, and the comparison of this sum for each pair with the sum of the number of times each pair was present and available to each other for at least one social contact during the period of observation. The data from each of the eighty observation periods are entered on two matrices. In one matrix the contacts are recorded as a "1" for each pair between which at least one contact occurred during the observation. In a second matrix the fact that two persons were present in the study hall is entered as a "1." The 7090 is to be used to add the two series of matrices and compare them with one another. Since the observations were taken over

a period of time, the ratio of contacts to presence for each pair of students will be taken in a cumulative fashion.

422-36001 Chemistry and Chemical Engineering. Shape of Echo Envelopes. A calculation of nuclear transfer effects in nuclear magnetic resonance will be carried out. The modified Block equations proposed by McConnell (H. M. McConnell, J. Chem. Phys. 28, 430 (1958)) have been used by Woessner to obtain the shapes of spin-echo envelopes in the presence of exchange, for the particular case of the two pulse method (D. E. Woessner, J. Chem. Phys. 35, 41 (1961)). These calculations will be extended to the shape of the Carr-Purcell echo envelope in the presence of nuclear transfer effects. The integrated equations given by Woessner will be used (equations 18, 19 and 22, 23 in D. E. Woessner, loc. cit.) These equations appear in complex form. Several subroutines that allow the handling of complex variables will be used, since it has been found that this is simpler than separating into the real and imaginary part from the beginning. The integrated equations in complex form are:

$$M = f_1(A,B,t)$$

$$N = f_2(A,B,t)$$

A and B are integration constants. It is desired to calculate M, N at $t = 2NT$ T = constant (real) $N = 1,2,3,\ldots,N'$. But at times $(2N-1)T$ the quantities M and N are changed into their complex conjugates. This gives rise to new values of A, B, so that A and B have to be calculated for every value of $N = 1,2,3\ldots,N'$. The values of M and N at $t = 0$ are given. All calculations involve simple algebra.

423-36002 Physics. Magnetic g-values. This problem is concerned with the determination of experimental and theoretical spectroscopic splitting factors (g-values) in electron spin resonance. The computer will be used to find those g-values which are a best fit to the experimental data by a least squares fitting procedure. It will also be used to compute the theoretical g-values obtained from the eigenvectors of a symmetric matrix which is obtained from the known or estimated crystalline electric field parameters.

424-36003T Theoretical and Applied Mechanics. A Problem of Thermoelastic Contact. The problem being considered concerns two infinitely long cylinders whose cross-sections are approximately rectangular. One surface of each

cylinder is slightly curved. These curved surfaces are brought into contact by a uniformly distributed compressive load. A temperature gradient between the cylinders may also exist. The object of the investigation is the determination of the size of the area of contact.

A trigonometric-hyperbolic series is assumed as the solution of the biharmonic compatibility equation of plane strain. The boundary conditions lead to an infinite set of linear equations.

The IBM 7090 will be called upon to compute the coefficients of the equations, and to solve the set of N simultaneous equations which result from truncation of the original set.

425-36004 Electrical Engineering. Crystal Filter Synthesis. From an initial rough design of a crystal filter, steepest descent techniques will be used to achieve a final design, when loss and parasitic elements are considered. Design tables will be the final result of this research.

426-36005T Physics. Determination of Decay Constant. Circularly polarized monochromatic Cesium resonance light is passed through a cesium vapor cell, optically pumping the cesium vapor. The intensity of the transmitted light is monitored by a photocell, the output of which is photographically recorded by an oscilloscope. By interrupting the light beam for variable lengths of time, a series of points is obtained which gives an exponential curve representing relaxation phenomena. The machine computation of this curve is desired.

The method of computation follows. Given N data points (X_i, Y_i) to be fit by a function

$$Y = f(x) = A + Be^{\frac{-x}{C}}$$

The optimal values of A, B, and C are found by obtaining an approximate minimum of the function

$$R = \sum_{k=1}^{N} \left\{ f(x_i) - Y_i \right\}^2$$

and the minimization is in the three dimensional space of the parameters A,B, and C.

The calculation proceeds by 1) reading in values of the data, X_i and Y_i ; 2) reading in initial guesses of A, B, C; 3) establishing criteria for the accuracy with which the minimum of R is to be found; 4) minimizing R. The final values of A, B, C are printed out.

427-36006 Food Technology. Flavor of Evaporated Milk. This research problem consists of a study of the effect of various processing conditions and storage temperatures upon the flavor of evaporated milk. While the bulk of the work deals with the chemistry of the flavor, the phase for which the IBM 7090 is to be used consists in establishing the relationship between the various processing and storage conditions and the flavor evaluation of the products by a panel of expert judges. The experimental design was selected so as to perform an analysis of the variances of the flavor evaluations. However, due to the necessary absence of some of the judges during the scoring periods, a least square analysis must be employed. This procedure can be performed by the IBM 7090 with considerable saving in time.

428-36007T Aeronautical and Astronautical Engineering. Thermal Vibrations. The thesis is concerned with thermally induced vibrations in viscoelastic beams, for which the solution requires a mathematical analysis not amenable to hand calculations.

The first problem concerned is a double numerical integration required to find the average fluidity of an aluminum beam, the average taken with respect to both time and the cross-sectional area. Simpson's rule is used in this problem.

The section part of the solution is concerned with finding the deflection of the beam by use of the method of successive approximations. Since no exact solution for finding the deflection of a non-homogeneous beam could be found, the approximate method was resorted to. This consits of first approximating the material property by letting it vary in a step-function fashion and finding the deflections accordingly. The final step then consists of matching the initial points at each point where the material properties are changed.

429-36008 Physics. Greatest Common Divisor. The purpose is to learn greater facility in Fortran programming and to learn Scat programming.

The routine finds the Greatest Common Divisor of a set of non-random Floating point numbers which should be within a specified error. There may also be a difference in the weight applied to different elements of the set.

Numbers are tested by division of the smallest into the rest of the set, seeking integer multiples of the first. After exceeding a preset no. of misfits a higher number is chosen as the multiple of the 1st (least) number; if this doesn't work succeeding elements in the set are chosen.

In all, 12 successful combinations are found. The best is then selected and printed.

430-36009 Animal Science. The Tryptophan Nutrition of the Pig. The nature of this problem is to determine the amount of tryptophan required by the weanling pig to produce the greatest rate of body weight gain and the most efficient utilization of feed.

The data will be analyzed by the method of least squares.

431-36010 Physics. Optical Potential Calculation. The Optical potential for the scattering of a K^- meson in nuclear matter may be approximated by the formal expressions

$$\bar{U} = < t >, \qquad (1)$$

$$t = t + t \left(L \frac{1}{d} - \frac{1}{d} - \frac{1}{a_F}\right) t \qquad (2)$$

$$d = a - \bar{U}, \qquad (3)$$

where $\frac{1}{a}$ and $\frac{1}{a_f}$ are the "bound" and "free" Green's function representing the K^- nuclear and the K^- free nucleon systems respectively. The averaging represented in equ (1) is over the Fermi sea. The operator t in equ. (2) is the free scattering matrix.

An outline of the principle feature of the numerical solution of these equations is as follows: By assuming zero range interactions (e.g., t is zero range) the integral equation (2) reduces to an algebraic expression together with a double integration over the Green's function ($\frac{1}{d} - \frac{1}{A_F}$).

The averaging in equ. (1) involves another double integration. The appearance of $\bar{U}$ in (3) requires that the equation be iterated; code checking experience on another machine has shown that convergence can be expected in 3-4 iterations. To carry out the quadruple quadrature the program uses four copies of a special integration routine which automatically picks the points, breaks the interval, and chooses the proper Newton-Cotes quadrature rule depending on the error specified and the nature of the integrand.

432-36011 Digital Computer Laboratory. Bubble Chamber Scanning. The computer will be employed to test the expansion of MACRO'S which are to be used in a program for scanning bubble chamber negatives.

433-36012T Civil Engineering. Lateral Torsional Buckling of Plane Frames. The program is concerned with the determination of the lateral torsional Buckling Load of plane frames loaded in the plane of the frame. The program makes it possible to study the effect of lateral bracing stiffness, lateral bracing spacing, and beam cross sectional geometry on the buckling load of the frame.

A set of simultaneous linear differential equations having variable coefficients is solved using numerical integration. The trapezoidal integration method is used. Due to the nature of the structure studied, it is necessary to use successive approximations to find the buckling load.

434-36013 Agricultural Economics. The Structure of the EEC Export Market. The objective of the study is to provide (1) a survey of the commodity structure and geographical distribution pattern of EECs imports, (2) an analysis of the major economic and institutional forces that shape the course of EECs commodity imports, and (3) an estimate of EECs future import requirements in general and that from the United States in particular.

The analytical phase of this study encompasses ten types of commodity aggregates, 12 regional import sources and built around a total of 146 variables. Clearly the formulation and statistical fitting of relations that describe the pattern and structure of international commodity transactions would be impossible without the aid of the IBM 7090.

435-36015 Mining, Metallurgy and Petroleum Engineering. Line Shape Integrals. In the study of nuclear magnetic resonance absorption spectra there arise cases in which certain basic line shapes associated with crystal orientation must be treated so as to include effects of symmetric absorption line broadening mechanisms. These effects can generally be taken into account by integrating the product of the basic line shape function, and that representing the broadening, over a region including the non-zero values of the functions. The integrals which occur can not be evaluated in closed form so methods of numerical integration are to be used.

436-36016 Food Technology. Sweet Corn Maturity. The present research problem attempts to determine possible significant measures of corn quality based on the growth maturity of the raw corn when harvested.

The IBM 7090 is to be used for doing the work involved in correlating and performing analyses of variance on the raw data. Standard routines are available for this work.

437-36017 Extension Division, Counseling. Interests and Sex, Age, and Intelligence. The research problem concerns the relationships of each of ten interest measures (dependent variables) to sex, age, and intelligence (independent variables). The interest measures used are the scores yielded by the Kuder Preference Record, Vocational Form-C. The index of intelligence is The Science Research Associates' Primary Mental Abilities Test. Data are available for 3325 subjects. The ratio of males to females is approximately 2:1.

The data cards will be sorted into two groups according to the sex of each subject. For each sex group, the IBM 7090 will be used to obtain Pearson product moment correlation coefficients for the relationship between each dependent variable and the independent variables of age and intelligence. Also, for both sexes, the correlation between age and intelligence will be obtained.

438-36018 Astronomy. Observable Space Volumes. It is proposed to evaluate the observable volume of space in the universe contained within a distance corresponding to a given red-shift, by using formulae developed for relativistic models with zero cosmical constant. Since the volume depends not only on the red-shift but also upon the space curvature and the acceleration factor, the evaluation will be carried out for a series of red-shifts and acceleration factors using each of the three possible values of the curvature constant.

439-36020T Aeronautical and Astronautical Engineering. Wing Flow Field. The thesis problem is to evaluate the flow field about a delta wing due to a pair of vortices. The problem is in three parts; first, evaluation of the boundary conditions due to the vortices, second evaluation of an integral

equation satisfying the boundary conditions, thirdly, evaluation of the total flow field about the delta wing. An analytic expression for the boundary conditions is to be approximated by a polynomial fit.

440-36022 Psychology. Personality Structure of Children. This general problem has led to the gathering of two sets of data.

Set 1. Objective personality tests on a representative group of 12-year old children.

Set 2. Objective personality tests on two sub-groups of normal children and maladjusted and emotionally disturbed children.

In each case the data will be factor-analyzed and rotated. Finally, results from the different sets will be compared using a variety of statistical procedures presently being programmed.

Instructional Problem Specifications

During the month of June, 1 instructional problem specification was submitted for the IBM 7090.

166-36021 Chemistry 490. Problem 1. Chemical Short Course in 7090. Write a program to read a number Y from a card with format E15.10 and print Y and X, where X is the solution of the equation $Y = X^2 + e^x + \sin\frac{x}{2}$.

Use the iteration method discussed in class.

Assume $1 \leqslant Y \leqslant 100$ and find $X \geqslant 0$

Information on the utilization and reliability of the IBM 1401 and IBM 7094 for the month of June, 1963 is given in the tables below.

TABLE I - IBM 1401

Summary of Use

June, 1963

Scheduled Engineering	12:55
Unscheduled Engineering	58:35
Maintenance	3:50
7094 Preparation	313:23
Deck Reproduction	1:46
Listing	22:16
Code Checking	26:46
CDC Preparation	:10
Tape Copy	:12
Tape Dump	5:55
Statistical Services Unit	1:00
S.M.P.	15:39
Tape Test	11:17
Idle	52:58
	513:47

TABLE II - IBM 1401

Summary of Machine Errors

June, 1963

1401 Main Frame and Storage	8
1402 Read-Punch	11
1403 Printer	7
729V Tape Units	3
	29

TABLE III - JUNE, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	IDLE	MAIN-TEN-ANCE	TOTAL RUNNING TIME	FAILURES	IBM - 1401 DAILY TIME DISTRIBUTION
6/1/63	7:35					7:35		
6/3/63	15:35			:20	:15	16:10	1	(1) Card jam damaged brush in 1402 Punch. Brush replaced.
6/4/63	21:18			1:27	1:15	24:00	3	(1) Density lights on Tape Unit A burned out and replaced by CE. (2) 1402 Reader chews edge of cards. Joggler adjusted on 6-5-63. (3) A continuous "End of Forms" check occurs on 1403 Printer.
6/5/63	20:39			3:01	:20	24:00	1	(1) A series of reader checks occurred and disappeared when engineer adjusted joggler on 1402 reader.
6/6/63	21:43			2:02	:15	24:00		
6/7/63	22:15			1:35	:10	24:00	1	(1) Continuous reader checks due to warped cards.
6/8/63	5:20			2:40		8:00		
6/9/63	10:10					10:10		
6/10/63	15:50		2:10		:15	18:15	4	(1) "End of Forms" and "Forms Check" on 1403 Printer. Trouble found to be faulty micro-switch. (2) Constant reader-stops on 1402 reader due to warped cards. (3) Unit B taken off-line when it failed to write the 'C' bit. Trouble found to be dirty tape head. (4) Tape unit B failed to write tape. Write skew found by engineers and corrected.
6/11/63	22:55		:50	:15		24:00	1	Corrected above trouble on unit B and also replaced rollers. (1) Engineers adjusted forms check on 1403 printer.
6/12/63	22:25			1:10	:25	24:00		
6/13/63	18:15		5:45			24:00	4	(1) Carriage runaway on 1403 printer. Left stop magnet value was broken and replaced by engineer. (2) Carriage runaway on 1403 printer. Lock washer worked loose and was tightened by engineer. (3) 1402 reader-punch will not read 2nd card through. Engineer adjusted clutch and trouble disappeared. (4) Power kicked off. 6-volt power supply Circuit breaker was tripped and adjusted by engineer.

TABLE III - CONTINUED

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	IDLE	MAIN-TEN-ANCE	TOTAL RUNNING TIME	FAILURES	IBM - 1401 DAILY TIME DISTRIBUTION
6/14/63	17:18		6:27		:15	24:00	3	(1) Lost power on 1401. Reset circuit breakers on power supply and it worked all right. (2) Reader side of 1402 read-punch makes a terrible noise. Engineer greased clutch and sound disappeared. (3) 1402 reader not feeding properly. It kicks out good cards and seemed to be trying to feed 2 cards at once. Trouble not found.
6/15/63	12:30					12:30		
6/17/63	14:00			1:40	:20	16:00		
6/18/63	10:10			13:30	:20	24:00		
6/19/63	17:18			6:42		24:00		
6/20/63	5:35	12:55	:40	4:50		24:00	2	(1) Level on card number #1 in 1402 reader bounces. Adjusted by engineer. (2) Constant reader checks. Engineer found short in read brushes.
6/21/63	18:15			5:45		24:00		
6/22/63	4:13			3:41		7:54		
6/24/63	15:35			2:55		18:30		
6/25/63	15:00		8:45	:15		24:00	2	(1) 1401 will not write on either tape unit. Engineers found RDD 144 card bad and replaced same. (2) Stacker select which was not working properly was also adjusted by engineer.
6/26/63	19:55		4:05			24:00	2	(1) Run-away carriage on 1403 printer. Loose nut on carriage stop magnet found and tightened by engineer. (2) Run-away carriage on 1403 printer. Valve stem was broken and replaced by engineer.
6/27/63	14:54		9:06			24:00	1	(1) Continuous process error on 1401. Trouble disappeared.
6/28/63	16:08		7:52			24:00	2	(1) Continuous process errors on 1401. Cannot load in new program. Trouble disappeared. (2) Power went off on 1401. Loose cable was found and tightened up.
6/29/63	8:12			1:10		9:22	2	(1) Continuous process errors on 1401. Trouble disappeared. (2) The 1401 won't write tape. Trouble disappeared.
6/30/63	5:21					5:21		
	398:24	12:55	45:40	52:58	3:50	513:47	20	

TABLE I - IBM 7094

Summary of Use

June, 1963

Scheduled Engineering	168:53
Unscheduled Engineering	7:01
Air Conditioning	9:25
Production	417:57
System Updating	1:46
Tape Testing	5:12
Operator Manipulations (Tape changing, cleaning, etc.)	82:08
	692:22

TABLE II - IBM 7094

Summary of Machine Errors

June, 1963

7094	2
7631 Disk File Control Unit	6
729 VI Tape Units	4
716 Printer	1
Air Conditioning	2
	15

TABLE III - JUNE, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANIP. OF TAPE	TOTAL TIME	FAILURES	IBM - 7094 DAILY TIME DISTRIBUTION
6/1/63	17:24					17:24		
6/2/63	14:53					14:53		
6/3/63	22:16	:40			1:04	24:00		
6/4/63	17:54	:48			5:18	24:00		
6/5/63	15:38	:45			7:37	24:00		
6/6/63	21:53				2:07	24:00	1	(1) Machine error halt at location 06105.
6/7/63	16:43	1:35		2:10	3:32	24:00	2	(1) Power checks due to air conditioning. (2) Machine error halts at 06105.
6/8/63	15:40					15:40		
6/9/63	24:00					24:00		
6/10/63	19:36	1:40			2:44	24:00	1	(1) Tape unit R jammed and was fixed by engineers.
6/11/63	18:53	1:30			3:37	24:00		
6/12/63	17:01	2:00	:58		4:01	24:00	2	(1) Brake on file reel would not release on tape unit R. Trouble found to be bad card. (2) Engineers checking disk file on line.
6/13/63	18:57	1:30	1:15		2:18	24:00	3	(1) Engineers checking disk file on line. (2) Tape unit Q broke a tape. (3) 716 printer had continuous carriage run away problems. Trouble disappeared.
6/14/63	12:40	1:35	:10	5:35	4:00	24:00	2	(1) Air conditioning failure caused power check. (2) Engineers checked disk file on-line. Found write parity errors on module "O".
6/15/63	21:20					21:20		
6/16/63	24:00					24:00		
6/17/63	18:46	4:10			1:04	24:00	1	(1) Engineers checked disk file on line.
6/18/63	8:21	14:00			1:39	24:00		7090-7094 Conversion
6/19/63		24:00				24:00		7090-7094 Conversion
6/20/63		24:00				24:00		7090-7094 Conversion
6/21/63		24:00				24:00		7090-7094 Conversion
6/22/63		24:00				24:00		7090-7094 Conversion
6/23/63		24:00				24:00		7090-7094 Conversion
6/24/63	[illegible]	[illegible]			7:58	24:00		7090-7094 Conversion

TABLE III - CONTINUED

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANIP. OF TAPE	TOTAL TIME	FAILURES	IBM - 7094 DAILY TIME DISTRIBUTION
6/25/63	11:26		:40		11:54	24:00	1	(1) Engineers working on disk file.
6/26/63	10:08	2:40	3:58	1:40	5:34	24:00	1	(1) Engineers working on disk file. Write parity errors on module "O".
6/27/63	10:32	2:50			10:38	24:00		
6/28/63	14:47	2:10			7:03	24:00		
6/29/63	23:05					23:05		
6/30/63	24:00					24:00	1	(1) Left reel hub will not engage on unit U.
	424:55	168:53	7:01	9:25	82:08	692:22	15	

USE BY DEPARTMENTS - JUNE, 1963

Department	Number of Runs			Total No. of Runs	Number of Problem Specifications			Total No. of Prob. Specs.	Time Used			Total Time Used
	Class	Research	Non System		Class	Research	Non System		Class	Research	Non System	
Aeronautical and Astronautical Engineering	5	8		13	1	2		3	:03	:04		:07
Accountancy			1	1			1	1			:10	:10
Agricultural Engineering		41		41		3		3		:27		:27
Agricultural Economics		71	15	86		6	4	10		2:19	6:00	8:19
Agronomy		115		115		11		11		1:44		1:44
Animal Science		2		2		1		1		:12		:12
Astronomy		2		2		1		1		:01		:01
Bureau of Community Planning		1		1		1		1		:04		:04
Bureau of Economic and Business Research		2		2		1		1		:07		:07
Bureau of Educational Research		10		10		1		1		:37		:37
Civil Engineering	105	618		723	5	29		34	2:20	19:36		21:56
Chemistry and Chemical Engineering		660		660		33		33		13:41		13:41
Communications		1		1		1		1		:05		:05
Digital Computer Laboratory		495	54	549		19	3	22		10:46	254:05	264:51
Dairy Science		25		25		1		1		:38		:38
Economics		3		3		1		1		:07		:07
Education		7		7		2		2		:16		:16
Electrical Engineering	58	305		363	4	15		19	:57	6:52		7:49
Forestry		1		1		1		1		:02		:02
Food Technology		2		2		1		1		:02		:02
General Engineering		4		4		1		1		:08		:08
Graduate School of Business Administration		7		7		1		1		:06		:06
Institute of Communications Research		110		110		3		3		4:45		4:45
Industrial Engineering	17			17	2			2	:17			:17
Industrial Education		11		11		3		3		:35		:35
Instructional TV		30		30		3		3		2:26		2:26
Mathematics	112	49		161	3	4		7	2:14	:24		2:38
Mechanical Engineering	6	204		210	1	12		13	:07	7:16		7:23
Mining, Metallurgy and Petroleum Engineering		76		76		3		3		:52		:52

Department	Number of Runs: Class	Number of Runs: Research	Number of Runs: Non System	Total No. of Runs	Number of Problem Specifications: Class	Number of Problem Specifications: Research	Number of Problem Specifications: Non System	Total No. of Prob. Specs.	Time Used: Class	Time Used: Research	Time Used: Non System	Total Time Used
Music		21		21		1		1		:25		:25
Natural History Survey		1		1		1		1		:01		:01
Nuclear Engineering		104		104		3		3		2:04		2:04
Office of Instructional Research		23		23		1		1		:48		:48
Physics	20	755		775	2	21		23	:54	40:20		41:14
Psychology		270		270		23		23		14:49		14:49
State Geological Survey		2		2		1		1		:06		:06
Small Homes Council, Bureau of Residential Construction		3		3		1		1		:05		:05
Sociology		20		20		1		1		:57		:57
Statistical Services Unit		368	1	369		2	1	3		10:24	:05	10:29
State Water Survey		66		66		6		6		:58		:58
Theoretical and Applied Mechanics		222	1	223		12	1	13		4:27	:10	4:37
Sub Totals	323	4728	72	5123	18	234	10	262	6:52	150:15	260:30	417:37
Instruction		26		26		1		1		:20		:20
Grand Totals	323	4754	72	5149	18	235	10	263	6:52	150:35	260:30	417:57

PART VII

GENERAL LABORATORY INFORMATION

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-Time	Part-Time	Full-time Equivalent
Faculty	16	0	16.0
Visiting Faculty	3	1	3.5
Research Associates	3	2	4.0
Graduate Research Assistants	3	46	26.7
Graduate Teaching Assistants	0	3	1.0
Professional Personnel	2	0	2.0
Administrative and Clerical	7	1	7.5
Other Nonacademic Personnel	45	50	72.5
TOTAL	79	103	133.2

The Computer Advisory Committee consists of Professors H. C. Brearley, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During June a total of 73 drawings have been processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	11	3
Medium Drawings	0	1
Small Drawings	6	1
Miscellaneous	2	0
Reports	65	0
Change Orders	0	0
P. C. Layout	0	0
	68	5

Many electrical and mechanical sketches have been made in order to arrive at a final method and procedure for fabrication of the PAU Stalactite board.

(K. C. Law, Paul Richardson)

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM
PART II - ILLIAC II SYSTEM PROGRAMMING AND OPERATION
PART III - CIRCUIT RESEARCH PROGRAM
PART IV - IBM 7094-1401 SYSTEM
PART V - GENERAL LABORATORY INFORMATION

JULY 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction

In terms of transistor counts the following progress has been made during July.

Chassis inspected	221
Chassis wired	423
Chassis in wiring	368
Chassis layout	131
Printed circuits (179 cards)	817

In addition the following corrective efforts were made on card circuits:

Repairs	69 cards
Engineering changes	11 cards
Modifications	75 cards

(T. Kerkering, F. Serio)

2. Documentation

The printed-circuit and card-specification binders have been distributed to the authorized persons in design, maintenance and fabrication. A summary section is now being compiled to aid in the use of this data.

(D. Chow, F. Serio)

A meeting was held to discuss the drawing standards to be applied to the final logic drawings for card circuitry. A memorandum will be forthcoming.

(S. Krabbe, K. Law, H. Lopeman, Y. Yen)

3. Component Testing

The evaluation of transistor behavior within the machine continues. Transistors in chassis Q7R#1, A7R#1, S7R#1 have been tested and pedigreed this month. Pedigrees on 500 2N967 which pass all GF45011 specifications are complete. These will be put in repetative MAU chassis as soon as possible.

Acceptance tests were run on about 3,000 transistors, including 1,000 S166, and about 1,200 diodes of assorted types.

(B. Doden)

4. Power System

a) Power turn-on for future input/output channel racks will be implemented via a plug-in relay control module. Mechanical work on a first model of this module is complete.

b) The wiring of the raw power distribution system for the channel racks must await a machine shutdown.

c) Plans for ac-power outlets to service the 1414 tape controls and tape units have been given to the electricians. Power outlets for both disc file controls and one disc file are ready for use.

d) Power margins of $\pm$ 5 per cent have been run on the main frame high voltages without error.

5. Core Memory

One recurrent parity error occurred in one program during July at address 1230_8. Sufficient time was not available to search for the cause and no other information was obtainable due to the random nature of the data words causing the error.

Two transistors (type 2N967), both located in the digit drivers, have shorted recently. It was known that pulse current for these transistors exceeds ratings and that the N250's, which were specified originally, should be returned to the digit drivers. The 2N967's were used as an experimental modification.

Aside from these two minor difficulties, the core memory has operated properly since June 11. Total dc time is now over 11,000 hours.

(S. R. Ray)

6. Magnetic Drum Memory

It was found that the phase delay from a write current transition to the peak of the corresponding read voltage pulse was rather variable. One reason was that the delay was a function of write-current risetime (and overshoot, if any), with faster risetimes giving earlier read voltage peaks. The variation in write-current risetimes was traced to variations in inductance from one head to another. The drum purchase specification showed a maximum inductance value, but no minimum. Measurements made this month on 253 heads on drum serial number 129 show an inductance distribution similar to a normal distribution with the high end cut off, as shown in Fig. 1. The absolute value of inductance is of less interest than the spread. To reduce the spread, the small number of heads below 40 and above 68 microhenries will be replaced.

Another solution to the problem of the spread in delay times is to add a stage of buffering in each of the 14 data paths. This was done at almost zero equipment cost by changing the method of signal transmission from the peak detector memory element to the output register. A third partial solution is to reduce the value of the write capacitor from 1500 to 800 pf to eliminate current overshoot with the low inductance heads. All three solutions are being implemented.

One of the worst patterns discovered so far is 0000110100000000, written repeatedly on a track. The problem is that the second "change-to-1" read pulse is crowded and reduced in amplitude, sometimes to the point of undetectability. The problem can be overcome by reducing the value of the read capacitor, which discriminates slightly against the long wave length signals, and by changes in the peak detector.

At the end of the month, three full two-bit chassis of read-write electronics had been built, and two were in use, along with a one-bit prototype chassis. The result was a drum memory that would write and read four bits plus parity out of each quarter word sent to it from Interplay. Test programs which exercised the available drum addresses in this five-bit mode were run, some successfully. All addresses were not used because (1) only drum 1 was physically present and (2) some addresses contained damaged tracks.

The strobe delay circuits were changed to operate with the new peak detector. Current values of delay between successive strobes are as follows:

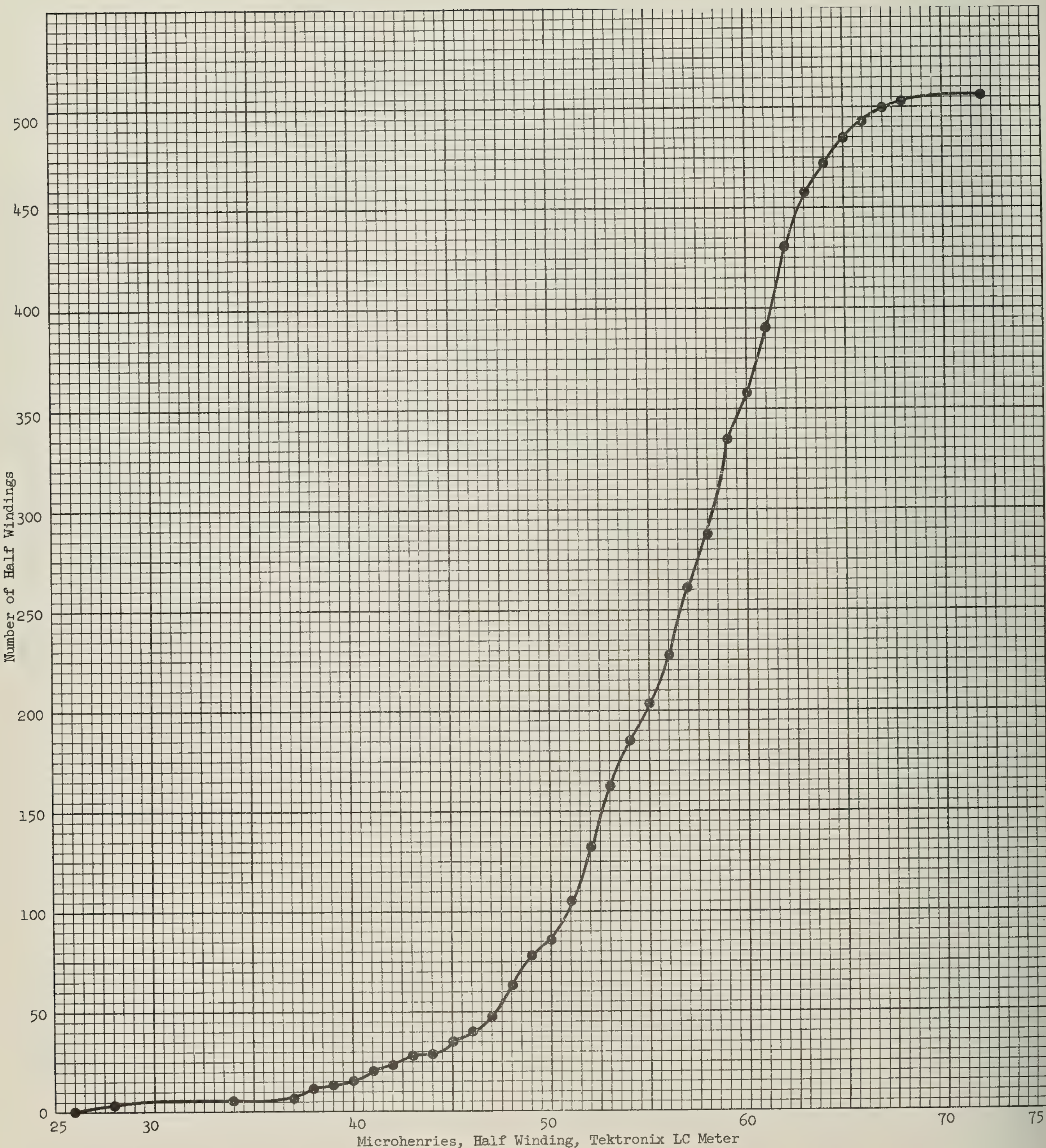


Figure 1. Inductance Distribution of 253 Heads on Drum 129

Write Strobe	
	.2 to .7 μsec
Write Strobe Delayed	
	.4 to .9 μsec
Read Strobe	
	.6 to 1.1 μsec
Read Strobe Delayed	

The new clock chassis was installed; it works very well. A new Read Inhibit circuit was installed. Some trouble was experienced with "Slow circuit" F-elements switching to the wrong state at the end of a gate pulse. This was cured by changing a number of slow diodes, T1G, to fast diodes, S577G.

(H. C. Brearley, M. D. Freedman)

7. Drum Channel Control

Several bit errors were found. The contributing factors were inadequate air conditioning and faulty components. A change is also necessary in the $\overline{\text{COD}}$ drivers that drive bit lines to the drum.

(S. P. Krabbe)

8. 1401 Channel

Tidying measurements and adjustments in the 1401 Channel Control, interface, and Interplay control have been made. Some results of these measurements and adjustments are as follows:

1. That part of the IPC cycle which is synchronized with a core memory cycle now ends before the core cycle is finished.
2. Word buffers fail to set if IPC control step number 4 is less than .3 μsec in duration.
3. Buffer word clear and gates overlap by .5 μsec, and cause errors, if a particular clear driver is too slow, as may occur if a slow 2N2000 input transistor is used.

4. Drivers of the $\bar{0}$ GD class should use fast transistors with $BV_{bc} \gtrsim 20$ volts at 100 μa, $BV_{eb} \gtrsim 4$ volts. Recommend GF45011 or equivalent.

5. Replaced $\bar{0}_e$ and $\bar{0}_d$ (used for driving small loads) with $\bar{0}_b$ and $\bar{0}$ respectively where needed.

The 1401 channel now transfers data currently. To be specific--256 word blocks and partial blocks.

The logical design has also been changed such that the 1401 can terminate a transfer before completing a full word. During a PID, if the transfer is terminated before the whole word is assembled the remainder of the word contains all 1's.

The logical drawings associated with the 1401 channel (ICC7) were updated together with SRDP, $SR30_8$ and $SR35_8$.

(S. P. Krabbe)

9. Special Register Distribution

$SR30_8$ is checked out. $SR35_8$ is partially checked out but needs some modification.

0 GD_c drivers, driving generally distributed cables were changed. These drivers previously were driving two cables (a) and (b). (See SRDP SSn bits, gOut, gIN.) The drivers were changed to 0 GD_f. Each cable is now driven by a single driver.

(S. P. Krabbe)

10. Interrupt and Special Registers

The design, layout and drawing of the Interrupt and Special Register area was completed and partly checked out. Included in the additions are a real time clock, a switch special register and an intermediate version of paper tape reader/punch. The final version of the latter two devices awaits the final console installation.

A list of changes and corrections to File No. 517 describing this area was prepared and given to M. Levin. Levin has written some preliminary debugging programs.

(L. Byers, M. Faiman, R. Kingsley,
H. Lopeman)

11. Delayed Control

File No. 555, "Delayed Control Speed Improvement" has been written.

(R. R. Shively)

12. Advanced Control and Interlock

Papers on these subjects are in preparation.

(D. B. Gillies, R. R. Shively)

13. Interlock and Block Checker

The new Interlock in NOR technology has been installed and checked out. This has had the immediate effect of allowing simultaneous operation of the Drum and the remainder of Interplay.

The Block Checker Chassis have been checked out and are available for use with Interrupt.

(R. Kingsley)

14. Test Console Interplay Channel

The logic layout and the wiring lists for the Interplay Channel Control of Channel 16 (Test Console Channel) have been completely finished. This Interplay Channel Control Circuit will contain 125 printed boards in five racks. The wiring of intra-rack connections has been done.

(Y. Yen)

15. <u>1414 Interplay Channel</u>

All logic has been generated and the last sections ($SR13_{10}$, BRPO, BRPI, DTC) are almost completely checked for logical design errors.

(B. Briley, M. Pisterzi)

16. <u>Multiple Consoles</u>

Now that ILLIAC II is nearing completion effort will be turned to programming and engineering for a large remote console system. Various aspects of this work are described in:

1) File No. 554, "On-Line, Time-Sharing Use of ILLIAC II," July 11, 1963, by G. Metze

2) Report No. 140, "Proposal for a Multiple Console System for ILLIAC II," July 12, 1963, by D. B. Gillies

17. <u>Engineering Programming</u>

In the month of July, numerous short and simple routines were generated for use in the checkout of the 1401 Interplay Channel. As a result of these tests, a new Engineering Test Routine, P1-BTC-50v, was written and code checked. The routine simply moves blocks of 256 random numbers to and from the 1401 and checks the transfer.

Work has started on a revision of File No. 541, "Notes on 1401-ILLIAC II Interplay Channel Codes, Hardware, and Operation."

(J. Bouknight)

During July, the final stages of checkout of the new control for ETR were made. Unlike the previous controls, this routine is the hub of operations of the entire test set. Each test is treated as a subroutine entered from and returning to the control. Various modes of operation are available to the engineer and can be selected using the 13 manual switches on the console (SR6).

Programs for testing of the drum have been written and will be available when the hardware to be tested is ready.

(G. Cooper)

In July, tests have been written for the CRM, ANM, ORM, NAM and NOM orders. These tests will eventually be included in a test of all orders involving modifier arithmetic. The first three tests are available now; the latter two will be available shortly.

The complete Modifier Arithmetic Test is expected to be finished by the end of the second or third week in August. Those persons wishing to use any of the tests already completed should contract me.

(W. Gorski)

A secondary test for ADD, called Delayed Add, P1-DAD-49v, was written and code checked. This test performs rapid additions with varying delays between each operation.

A set of four exponent tests (P1-EXT-51v) were written and code checked. These vary and test the exponent in several different manners. (See write-up of this test for details.) It is to be noted that these tests were useful in finding machine errors even during preliminary code checking.

Work is in progress on shift order tests.

(L. Huszar)

During July, the Mersenne Memory Tests (see June monthly report) were written in a completely self-contained, symbollic, "leapfrogable" manner and a report was issued (P1-MMT-48v).

Extensive work was done on the checkout of the Program Interrupt and Special Registers. Numerous short tests were written and are currently being used as checkout of this hardware continues. Eventually, many of these tests will be combined in a single Engineering Test Program of Program Interrupt and Special Registers.

Conferences with Michael Faiman led to a clarification of the demands and requirements for the Special Registers and a revision supplement to File No. 517, "Special Registers and Interrupt for ILLIAC II," by D. B. Gillies, has been prepared.

(M. Levin)

A test for all the store instructions has been written and partially code checked. The "special cases" are still to be checked out.

(B. Whitten)

Work was done on a test of the distribution of random numbers generated by G. Cooper's Random Number Generator.

(D. Chow)

PART II

ILLIAC II SYSTEM PROGRAMMING AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research

1. System Programs

The first three passes of the assembly program are on magnetic tape and have successfully run on some data. Further red tape operations need to be taken care of and a systematic check with all distinguished input data must yet be performed.

(H. Jarosch, C. Gear)

2. Trace Routine

Changes and additions are being made.

(F. Schaffer)

3. Output Routine

The Output Routine with Conversion for ILLIAC II is presently being checked out.

(M. Gaer)

4. Interrupt Programming

Work is progressing on the various phases of the Interrupt Program. Drum Interrupt and the Auxiliary Input-Output subroutine are ready to be checked out.

The format of several special registers has been determined enabling work to start on the Channel End and Error Interrupt conditions.

Interrupts due to illegal memory reference, protected and illegal orders, and accumulator overflow have been or will soon be wired. A temporary monitor system handling these conditions is being planned for use in September.

(J. Aaron)

5. Library Routines

Solution of Linear Equations and Matrix Multiply subroutines are written and code checked. Matrix Inversion with Solution of Linear Equations is written and presently being checked.

(J. Presti)

The data organization and checking section of the Inverse Laplace Transform subroutine is presently being code checked.

Some preliminary study of the Algol compiling language and compiling methods has been done.

(E. O. Brower)

6. ILLIAC I Simulator

A program to simulate ILLIAC I is being written in order that some use may be made of some of the unusual programs in its library. This program will eventually be available for occasional use for those who have an ILLIAC I program of great length, yet so seldom used that it is not worth converting manually.

(J. Bouknight)

7. Machine Use

Engineering Test Routines		
ETR	9:34	
Duplex Memory	4:09	
OLF	1:02	
Memory Reversing	10:24	
Crosstalk	1:09	
DAMN	29:03	
		55:21
Scheduled Engineering		96:49
Engineering and Use of 1401 with ILLIAC II		99:57
Drum Engineering with ILLIAC II		11:02
Interrupt Engineering		107:11
Code Checks		53:07
Math 001		46:47
Demonstrations		1:32
Jarosch (Checking Assembler Program)		32:27
*Power Off		5:13
Idle		40:04
Production		
Gillies	13:08	
Jordan	181:22	
		194:30
TOTAL USE		744:00

*Off during periods other than Engineering because of power failures.

Component Failures

Transistors		
Spontaneous	15	
Out of Spec	1	
		16
Zeners		
Spontaneous		2
Capacitors		
Shorted		2
TOTAL FAILURES		20

System Failures

Punch	1
Readers	5
Tape Parity (Punch or Reader)	4
Core Parity	8
Power Dumps	4
TOTAL	22

(W. L. Huffman)

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Gabor Ujhelyi and Sergio Ribeiro have obtained a 50 per cent modulation of light in a device that uses voltage pulsesto alter the index of refraction of nitrobenzene. They are also considering several photo-electric circuits and devices. This work will be continued on the arrival of components that have been ordered.

Henry Guckel has developed a relationship between the backward coupler and the distributed transformer terminated with one or more pairs of tunnel diodes. A frequency-independent directional coupler may be possible. Methods of rapid multiplication are being looked into, with the ultimate objective of using tunnel-diode-transmission-line amplifiers.

Louis van Biljon is continuing the investigation of avalanche breakdown, using several specially selected transistors. The effects of out-diffusion in the manufacturing process have been studied.

Thomas Burnside reports on several circuits that are to be used in the Statistical Analyzer.

2. Light Modulation

A device has been constructed in which a light beam propagates in nitrobenzene and is incident on the glass walls at an angle close to the critical angle. Electrodes are located above and below the path of the light beam, so that their electric field controls the index of refraction of the nitrobenzene. The light beam is polarized normal to the plane of incidence, and therefore parallel to the controlling electric field.

By a proper adjustment of the incidence angle and using a pulse generator we obtained about 50 per cent light modulation with pulses of ten kvolts.

Further experiments are in preparation in order to clarify some theoretical aspects of the system, for relatively little data is available about the properties of electrically bi-refringent substances.

3. Distributed System

The relationships between the backward coupler and the distributed transformer have been derived.

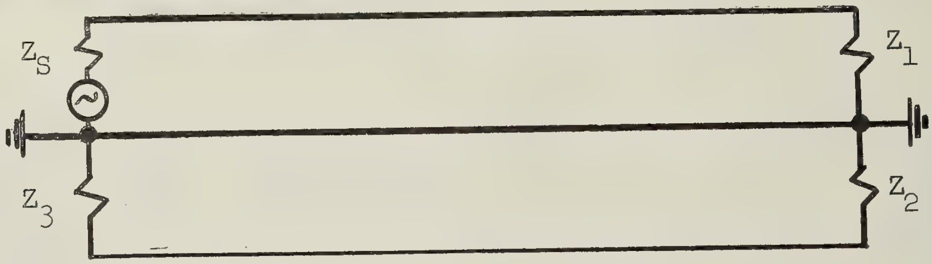


Figure 1

If

$$Z_1 Z_3 = Z_0^2 - Z_m^2$$

the voltage at Z_2 will always be zero. Hence, if a diode pair is operated in Region II, backward coupler action may be expected. Operation in Region I will result in the previously discussed transformer action.

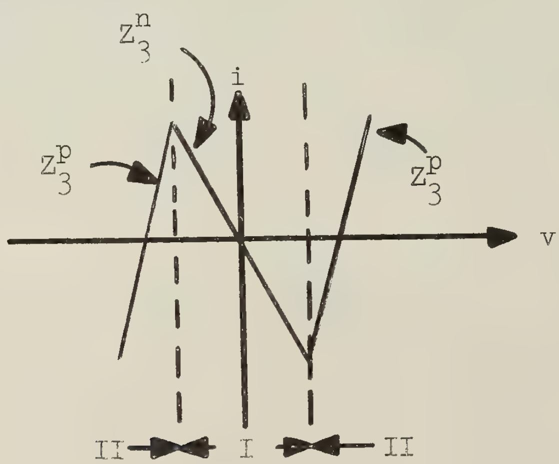


Figure 2

This type of behavior has two uses. It may be used to obtain a form of directivity. Furthermore, if it is desired to couple a high amount of energy to Z_3; for instance if Z_3 is a switchable circuit, this method may be used.

Some investigations have also been made into the feasibility of employing a similar network as a frequency-independent directional coupler.

4. Multiplication

It was suggested earlier that some of the tunnel diode circuits should be used in a high-speed multiplier for ILLIAC II. In order to understand the circuit requirements, different methods of multiplication have been studied. The following conclusions have been reached.

(1) If the multiplier takes the form of a serial subsystem a worst-case multiplication time of about five microseconds must be expected. The control circuitry, i.e., strobes, etc., will be quite complicated.

(2) If a parallel multiplier is desired a total time of about two microseconds will result unless special provisions are made for the carry. However, if this is done then the advantage over a transistor multiplier is small, and if cost considerations are added, is nonexistent.

These arguments apply only to standard multiplication methods. Reduction of the carry propagation time with special circuitry as well as logic will improve the parallel situation. The formation of the product by squaring, using

$$2ab = (a + b)^2 - a^2 - b^2 \qquad \text{or} \qquad 4ab = (a + b)^2 - (a - b)^2$$

has been studied and is useful in some cases. Further work along this line is in progress.

5. Avalanche Effect in Transistors

The investigation of base-collector multiplication was continued by measurements on specially selected transistors received from RCA, Bell and Fairchild.

As before, sharper breakdown curves than those presented by Miller were found, probably due to the much lower dissipation level in the present measurements.

Some planar diffused base transistors were tested to find whether the retrograding of a junction resistivity profile showed a sharper breakdown, as

had been predicted, than the normal forward graded junction. The base-collector junction was used as the "normal" one, while the base-emitter junction was the retrograded one; only three transistors of this type were available and as yet, no conclusive results could be found.

By making use of facilities provided by the Department of Metallurgical Engineering eight of the transistors under test were microscopically investigated to determine internal and external dimensions of the various regions. This was done in order to tie up calculations yielding current densities and the actual currents as measured; these calculations are still in progress.

At present the recent work of Baraff is being studied as this seems to remove some of the inherent contradictions between the approaches of Wolff and Shockley to depletion layer multiplication.

6. Statistical Analyzer

The following circuit will be used as the discriminator. (See February, 1963, Progress Report.)

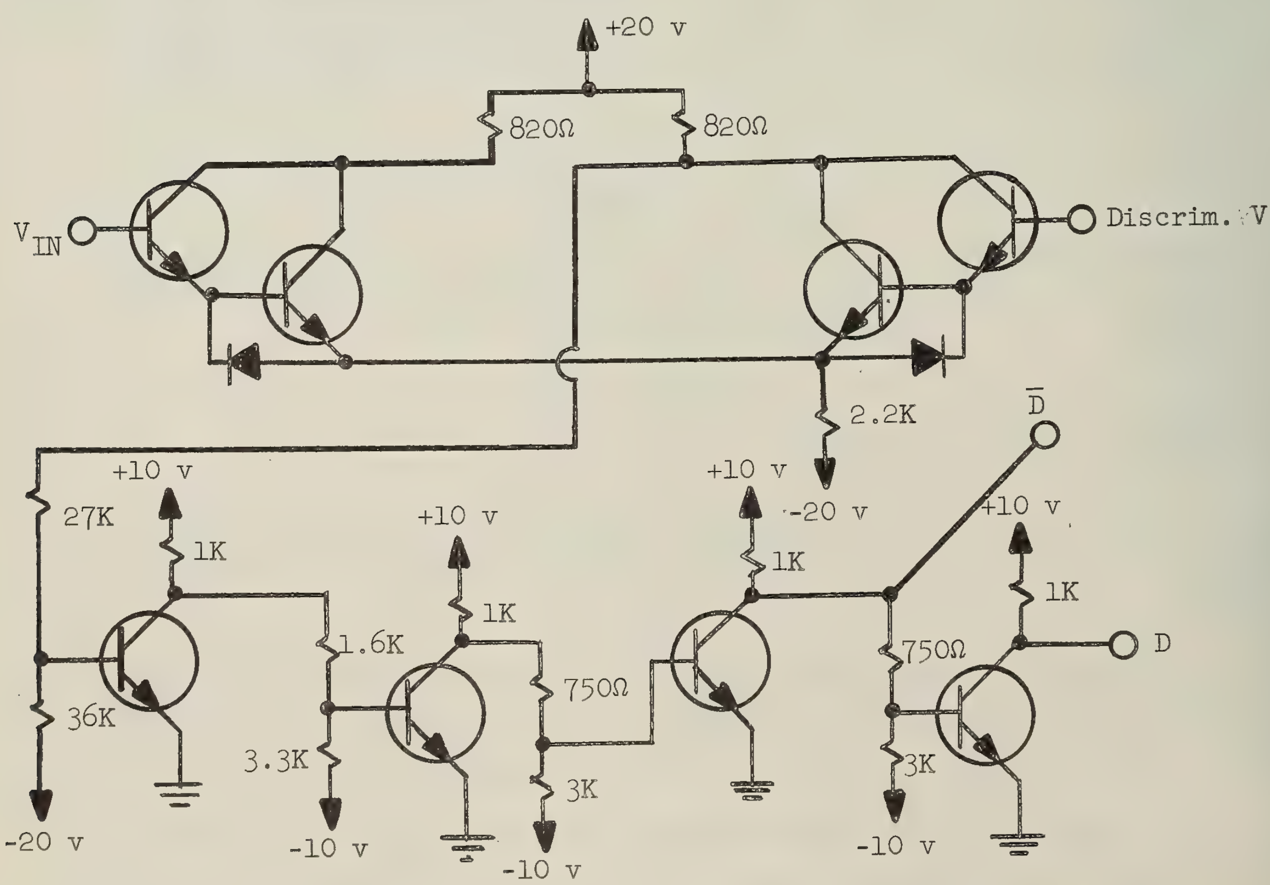


Figure 3. Discriminator

V_{IN} is the output of the sample diode circuit shown in Fig. 4.

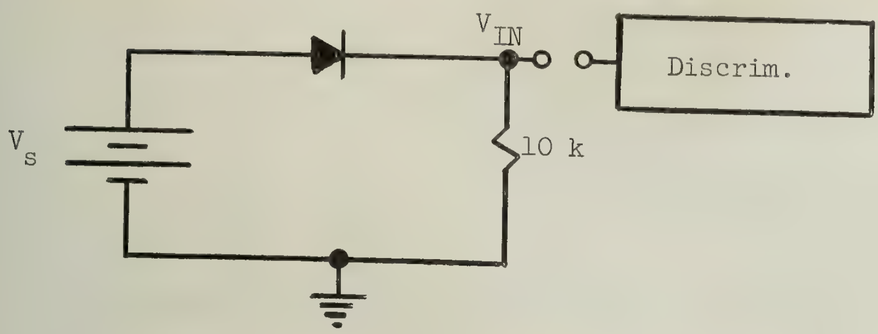


Figure 4. Sample Diode Circuit

Discrim. V is the voltage at which the discriminator will switch.

If V_{IN} < Discrim. V then D = 0 volts, a logical 0. If V_{IN} > Discrim. V then D = +6 volts, a logical 1.

Nine of these circuits will divide the input voltage into eight channels. (See June, 1962, Progress Report, Fig. 8, page 24.)

Bench tests indicate that the difference amplifier is sensitive enough to separate V_{IN} into .5-volt intervals with less than ten per cent error. The input impedance of the discriminator is in the order of 100 K.

A circuit is being built to provide the eight sample voltage sources, V_s, for the circuit. These values are to be:

$$V_1 = 2.25 \text{ v}$$

$$V_2 = 2.75 \text{ v}$$

$$V_3 = 3.25 \text{ v}$$

$$V_4 = 3.75 \text{ v}$$

$$V_5 = 4.24 \text{ v}$$

$$V_6 = 4.75 \text{ v}$$

$$V_7 = 5.25 \text{ v}$$

$$V_8 = 5.75 \text{ v}$$

These relatively high current dividers are shown in Fig. 5.

Also a circuit has been designed to provide the discriminators with proper bias voltages. The highest bias voltage may need to be as high as 6 volts and the lowest as low as 0 volts. Also the voltage intervals between the 9 voltages must be equal. The circuit in Fig. 6 has equal intervals to within one per cent error.

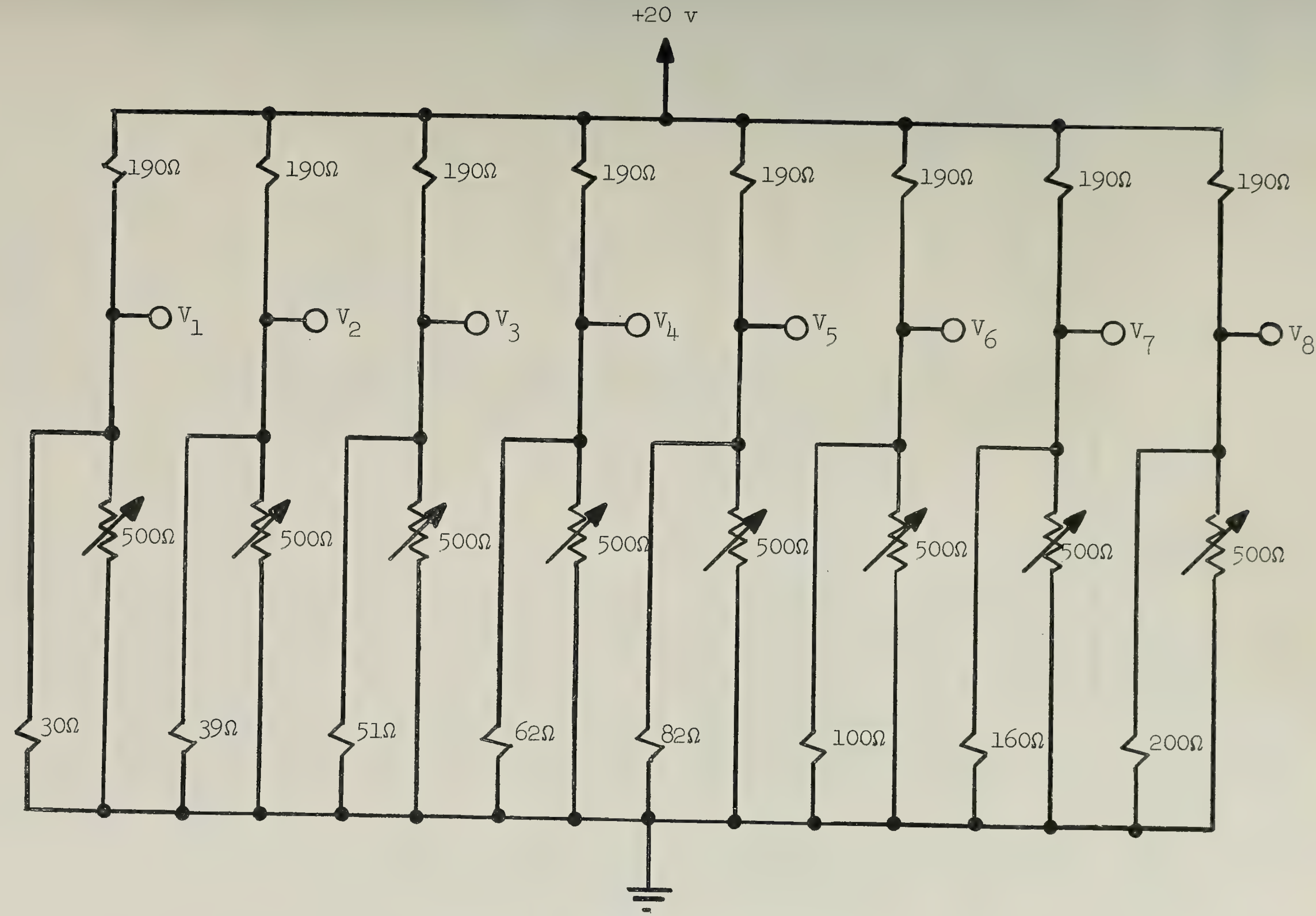


Figure 5. Sample Voltage Sources

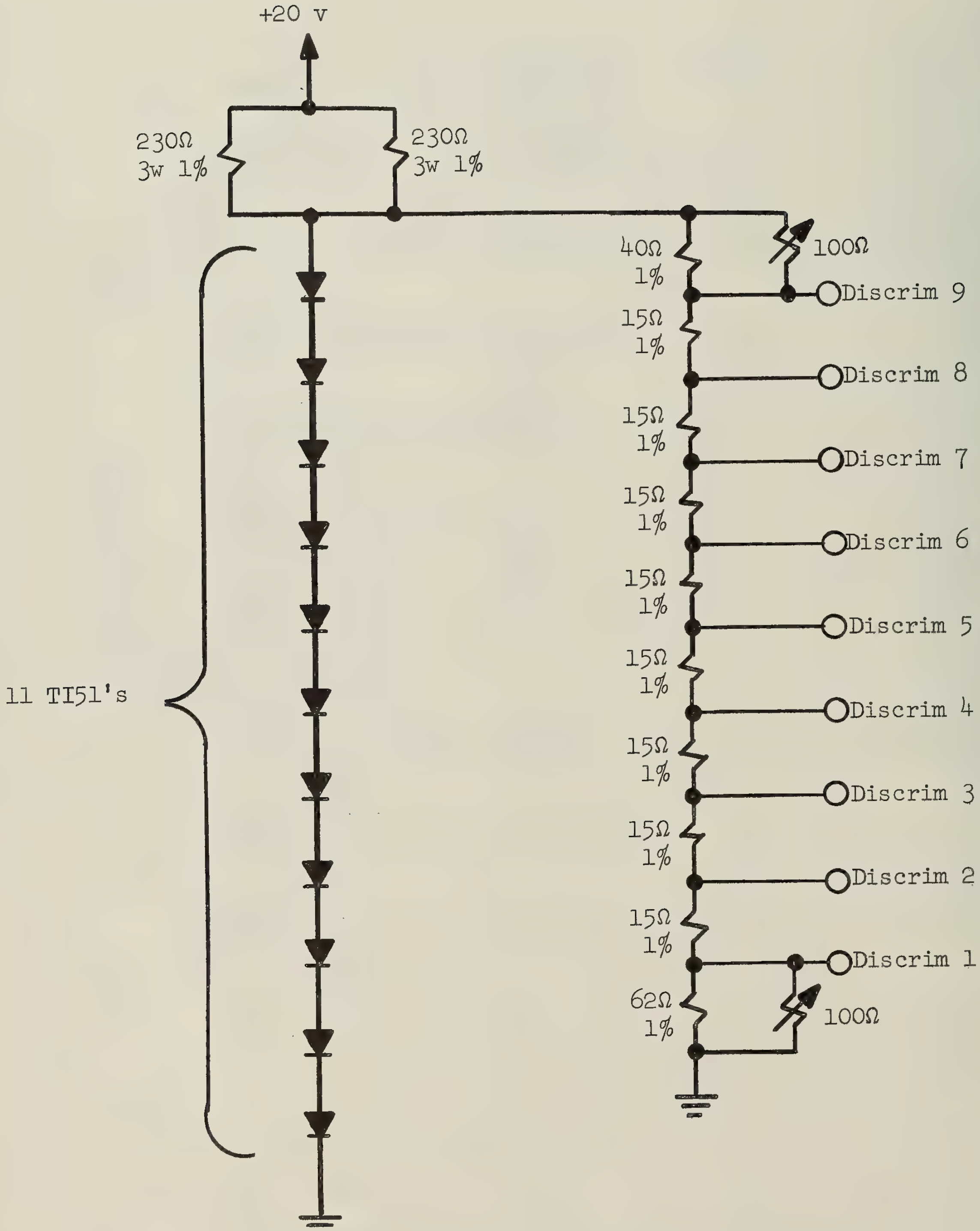


Figure 6. Bias Voltages for the Discriminators

PART IV

IBM 7094-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

NEW ROUTINES

B4-UOI-DSQRT-39-SR

Double Precision Floating Point Square Root

SCATRE, FØRTRAN, MAD. This subroutine computes the positive square root of a normalized non-negative double precision floating point number.

(D. W. Hutchinson)

B4-UOI-CUR4-40-SR

Double Precision Floating Point Cube Root

SCATRE, FØRTRAN, MAD. This subroutine computes the real cube root of any normalized double precision floating point number.

(D. W. Hutchinson)

During the month of July, problem specifications were submitted for the IBM 7090.

441-36019 Chemistry and Chemical Engineering. Bimolecular Exchange. The cross-sections and classical trajectories for homogeneous gas-phase exchange reactions are calculated by a Monte Carlo procedure for selecting initial states of the reacting system, followed by integration of Hamilton's equations by the Runge-Kutta-Gill method. The program is one which has successfully been used on the 7090 installations at the Thomas J. Watson Research Center, Yorktown Heights, New York, and Columbia University. Only modification for the Illinois monitor is required.

442-36023 Anthropology. Law Guage Comparison. This work is being done for a paper for Anthropology 317 and the program will compare corresponding sets of words from 4 different languages, to discover phonemic correspondences, and calculate the actual correspondence probability from the observed probability. From this data the probability of corresponding morphemes being cognate can be calculated, and from this the probable degree of genetic relationship between the languages

443-36024 Mechanical Engineering. Cam Curve Approximation Check. The exact pressure angle curve for swinging follower cam systems will be calculated using

$$\alpha = \text{ARCTAN}\left[\frac{\cos S - C_1\left(1 - \frac{dS}{d\theta}\right)}{\text{Sin } S}\right]$$

Where α = Pressure Angle

S = Characteristic of the cam system

θ = Cam Angle

C_1 = Constant

An approximate pressure angle curve using

$$\alpha = \frac{A}{Z} \text{ Sin } (Z\pi\theta) + B$$

Where θ = cam angle

A & B = Characteristic Const.

will be calculated and the exact and approximate solutions will then be compared using the computer.

444-36025 Chemistry and Chemical Engineering. Process Stability. Consideration is given to the transient behavior and stability of some non-linear chemical processes. Of particular interest are systems whose behavior is non-unique or oscillatory in time. Digital computation is required to obtain solutions for the non-linear differential equations.

445-36026 State Water Survey. Rainfall Rate Estimation. From raindrop size data, the radar reflectivity, Z; the rainfall rate, R, and the radar attenuation cross section are calculated. A need has arisen to make the best estimate of rainfall rate, R*, given a value for the radar reflectivity subject to the side condition that the sum S defined as $\sum R_i |R_i - R^*|$ is a minimum. This criteria is chosen so as to weight the higher values of the rainfall rate more than the low values so that the chance of underestimation is reduced. The incremental values of reflectivity will be chosen on a logarithmic scale so that B3-UOI-LOGI-8-S and B3-UOI-EXP5-4-S will be used.

446-36027 Bureau of Economic and Business Research. Old Age Finances. The objective of this study is to ascertain the extent to which the finances of older people differ from that of younger people. For this purpose, various cross-tabulations are needed of ownership of different financial assets and debts by age and other family characteristics and a number of multivariate relationships will be estimated to measure the relative importance of different family characteristics in explaining financial holdings.

447-36028 Chemistry and Chemical Engineering. Two Centered Integrals. This is part of a larger problem. It consists of evaluating certain two centered integrals used in the quantum mechanical evaluation of molecular structure and parameters involved in molecular structure. An exact and approximate solution is included in the program. Preliminary calculations indicate that the approximate solution is within 0.1% of the exact solution. If this is the case over the range where the integrals are commonly used there are two important applications. 1. Inclusion of this program as a subroutine in larger program (this presently is not done because of the size of the program) 2. Evaluation of the integrals in cases where the exact program requires an unusually large number of significant figures (the exact solution is a difference between to very large numbers. - The approximate solution is not) The method is the evaluation of integrals in analytical form of Roothan J. Chem. Phy. (1951) 1451)

448-36029 Psychology. Behavioral Classification. This is an attempt to establish a classification of children's emotional disorders. Intercorrelations among behavioral, demographic, and personal history variables, already determined for the initial phase and to be determined for the validational phase, are to be subjected to centroid factor analysis and to rotations, with filmed output for rotoplot rotations.

449-36030 Agricultural Engineering. Hydraulic Resistance in Shallow Open Channels. The objective here is to complete the development and testing of relationships between hydraulic resistance, as characterized by a dimensionless Chezy coefficient, and five geometric and dynamic variables hypothesized to influence resistance in open channels of extreme relative roughness. Analytical and dimensional analyses have been completed. The analysis of experimental results obtained with a model of a natural channel together with the accumulated observations of many workers from prototype channels has been partially completed with a desk calculator. At this point the 7090 will be used for a series of multiple regression analyses to test the validity of hypothesized relationships, and evaluate empirical relationships for comparative purposes. Present indications are that these relationships will be either semi-logarithmic or logarithmic in form, making machine calculation a necessity to obtain required precision.

The regressions will be accomplished through a sequential process of evaluating the reduction in error variance attributable to a given independent variable; if the reduction exceeds a pre-set standard, that variable will be added to the regression equation, a new coefficient matrix calculated, and a second variable inspected, etc. to repeat the process.

450-36031 Civil Engineering. Multibeam Bridge Analysis. The "Multibeam Bridge Analysis" is a thesis problem which requires considerable computation time, especially in connection with generating and solving up to 33 equations simultaneously. Most of the computations have been done here previously on the CDC 1604 and an IBM 1620 elsewhere.

Joint forces, reactions, shears, and moments are obtained as output.

451-36032 Civil Engineering. Beam Model. The solution of this "two-degree-of-freedom" system will be accomplished by using an energy procedure. The procedure will be to establish the total energy of the system and then to minimize

it. The solution is performed in steps with the total energy being modified after each step. This looping procedure shall be continued until the failure criterion of the model is reached. The problem shall involve at each step, the solution of three simultaneous equations.

452-36033 Civil Engineering. Traverse Closure. Given the direction and bearing of a set of lines inclosing a travese the problem is to compute the error in closer.

The purpose of the problem is to acquaint the student with the digital computer laboratory system.

453-36034 Psychology. Analysis of Some Superego Factors. Factor Analysis has previously found several dimensions in different psychological media which have been referred to as superego factors. The present investigation seeks to 1. replicate any and all of these factors, 2. extend the number of factors for further clarification of the factors, their similarities and differences, 3. relate these factors to major personality traits such as anxiety and extraversion, and 4. to see if, as hypothesized, delinquency is related to superego factors in 16 and 17 year olds when socioeconomic and intellectual influences are removed.

The 7094 will be ultilized to determine the reliabilities of the measures used, to examine the distributions of the variables, and to correlate and factor analyze the data.

454-36035 Institute for Research on Exceptional Children. Components Analysis of Academic and Personality Traits of Gifted Junior High School Students. Data pertaining to academic aptitude and personality traits of approximately 350 intellectually gifted junior high school students are to be analyzed and then related to the actual classroom performance of the students. In all, approximately 70 variables will be involved in the analysis.

The procedure is to analyze the academic aptitude and personality trait variables into a set of component (factor) scores for each individual student. The individual component scores, along with other data, are then to be related to classroom performance through multiple regression analysis.

It is anticipated that the following routines will be required in analysis of the data: (a) Routine to standardize the data matrices (raw scores), (b) routine to generate matrices of Pearson product-moment correlation coefficients, (c) principal axis factor analysis routine, (d) Varimax rotation routine to obtain orthogonal simple structure, (e) matrix inversion amd multiplication to obtain individual component (factor) scores, (f) multiple regression routine to relate component scores and other data to variables pertaining to classroom performance of the students.

Standard routines provided by the University of Illinois' Statistical Services Unit are to be used in processing the data.

455-37001 Civil Engineering. Cylindrical Shells in Elasto-Plastic States. Purpose of study is to investigate interaction of plane elastic waves with a thin, hollow, cylindrical shell embedded in an elastic medium. The shell may be a composite system, e.g., a concrete shell with a packing outer-ring, such as plastic foam.

Response of the shell is to be studied by assuming that the dynamic stress wave can be suitably represented by static loading.

General equations of the system are to be solved with use of digital computer. Iterative techniques may be employed.

456-37002 Agricultural Economics. Farm Size. Objectives of the Research:
1) To test the hypothesis of a closer relationship between size of farm and total farm production (and/or net revenue) when size is defined not in terms of acreage but in terms of total input.
2) To find the relationships between the size of three different types of farm and the efficiency of the use of the resources.
The 7090 would provide:
1) The calculations of the three year averages of total imput for each of approximately 500 farms of S. Illinois counties;
2) Their frequency distribution as to provide the basis for a classification of farm size comparable to the usual classification by acreage;
3) a logarithmic regression analysis for the three types of farms considered in the sample: grain farm, livestock farms and dairy farms, to determine the productivity of the inputs in these three different farm organizations.

457-37003 Physics. Quenching I. Under conditions of violent temperature change, thermally activated point defects may be trapped into a metallic lattice. The IBM 7094 is used to integrate the differential equation describing the defect population as a function of time, and in this way to predict the efficiency of quenching experiments.

458-37004 Physics. KPLUSH. An investigation is to be carried out to measure the low energy cross section of K^+ mesons in hydrogen. The Berkeley Bubble Chamber computer routines Pang and Kick will be utilized in the analysis. Further the routines, Examin and others to be written will be used to organize and manipulate the raw data.

459-37005 Physics. Thermometer Calibration. All low temperature thermodynamic measurements require the conversion of readings from secondary thermometers into absolute temperature values. The principal secondary thermometers for use below 4.2°K are resistive or magnetic elements which increase in value with decreasing temperature. Calibration involves determination of a suitable function, $X = f(T)$, where X is the observable thermometric parameter (resistance, or inductance) and T is the absolute temperature.

The reference standard for measurement of T from 4.2 to 1°K is the vapor pressure of liquid helium (He^4). The currently accepted values for He^4 constitute the "1958 Scale" which consists of a tabulation (by increments of 0.001°K) which is experimentally usable from about 1 to 5°K. The present research problem is to develop a code which will accept as input pairs of isothermally measured values of X, the thermometric parameter, and P, the helium vapor pressure. From these values the calibration function, X(T), will be determined for subsequent calculations.

The problem is a standard one for most cryogenic laboratories and several computer codes for this purpose have been devised. It is planned to make use of the FORTRAN routine described by P. R. Roach to the extent possible with the local computing system and consistent with local measuring practice. Roach's program goes considerably beyond the calibration problem and, after this phase of coding has been accomplished, the program will be extended to embrace the full routine outlined by Roach.

460-37007 Economics. Bank Model - 1. Nature of Problem: To develop a micro-analytic simulation model of the commercial banking system. Computer uses: (1) To estimate parameters for equations in bank models using standard statistical techniques. (2) To simulate banking and related economic processes using specially written programs.

461-37008 Civil Engineering. Pressing Stresses. The computer will evaluate the sum of a series which involves trigonometric and hyperbolic functions for two hundred combinations of two variables. This program computes the elastic stresses produced by a lateral load on a steel plate. Modifying these results to account for local yielding will enable estimation of the residual stress induced by the lateral loading. This information will be used to direct the pressing of fatigue specimens which should increase their life.

462-37009 Physics. Neutron Scattering. The purpose of this calculation is to study the energy and angular distributions of neutrons emerging from a long cylindrical absorber starting with a high energy neutron beam. A Monte Carlo calculation is proposed for the 7090 computer.

463-37010 Electrical Engineering. Error Probability of Self-repair System. The problem is to calculate the formulae obtained in the thesis research on self-repair systems. The formulae obtained so far involve only ordinary mathematical methods. It is expected that some important curves be plotted and examined to acquire more insight to the self-repairing action.

464-37012 Psychology. Crystallized 8 Fluid General Abilities. The main purpose of the study is to render a better empirical and theoretical description of general factors of intellectual ability.

A total of 109 measures of intellectual abilities and other personality characteristics, gathered on 297 subjects, are to be factored, first using the raw score variables, then holding age constant in one analysis, holding sex constant in another and holding both age and sex constant in a third. The factors are to be rotated to oblique simple structure: the correlations between factors are to be factored and rotated to simple structure and, if necessary, the factors among the factors are to be correlated and factored. A transformation is then carried out to bring all results to a single "primary" matrix.

Throughout routine statistical package routines are used - correlation, factor analysis, analytic rotations, and matrix operations. The visual rotations to simple structure, however, require use of the cathode tube.

465-37013 Bureau of Educational Research. Discrimination of Occupational Groups. A random sample of the population of 16 year old boys was tested with the general Aptitude Test Battery and a 15-score Interest Inventory. Approximately 600 of the boys could be followed up and classified, 5 years later, on the basis of the occupation they had chosen. The problem is to try to predict occupational choice from psychometric data.

Several mathematical models can be used (i) linear regression (ii) linear discriminant functions (iii) non linear discriminant functions (iv) weighted likelihoods. The 7094 will compute the accuracy of prediction for each of these models.

466-37006 Forestry. Light Reflectance (Terrain Features). Light reflectance from terrain features directly affects aerial photographs of those features. These reflectances are influenced by a large number of variables that make light reflectance difficult to measure. Replication is necessary and the mass of data required to provide reasonable information over a period of time (changes in influencing variables) makes considerable data processing and computation necessary. Computational problems have been the major factors limiting or preventing completion of research on light reflectance from terrain features.

Raw data consists of curves of light reflectance over wavelength. Data supplied to the computer consists of light reflectance values at predetermined, constant intervals of wavelength. Computations required:

1. Average reflectance values for each wavelength point in each series of replicates.
2. Standard deviations associated with the average values in 1 above.
3. Tristimulus coordinates for each raw curve and each average curve in the visible light spectrum.

467-37014 Civil Engineering. Blast Machine Simulator. The Civil Engineering Department is constructing a machine to study the effects of blasts on structures. This program will simulate the pressure use and decay characteristics of the machine to permit evaluation of the effects on these characteristics of physical changes in the machine. Standard library routines will be used.

468-37015 Theoretical and Applied Mechanics. Strain-Hardening of Plates. This problem investigates the plastic bending of circular plates in the strain-hardening range. The nonlinear stress-strain diagram is approximated by the first three terms of an odd polynomial. The total potential energy is then calculated as a function of the stress-strain diagram. The Rayleigh Ritz Technique is then used to minimize the total potential energy, resulting in a system of nonlinear algebraic equations.

These equations are then solved simultaneously to obtain the displacements of the plate, from which are derived the stresses and strains throughout the plate.

469-37016 Institute for Research on Exceptional Children. Efficacy of Special Classes. This study was designed to compare two educational settings for educable mentally handicapped children. One setting was special classes for these children, the other was placement in regular elementary grade classes.

After selection of approximately 120 subjects who were beginning first grade, half were placed in four special classes designed specifically for this study and the other half were left in the first grade. Placement in each of the conditions was accomplished by use of random means. The subjects have been followed for four school years, with varying kinds of data being collected during this period.

Analysis of these data is now underway. It is anticipated that both the 1401 and 7090 computers will be used to help analyze the large amount of data collected over the four year period. The study was completed with 93 subjects, on whom data are available for over 200 variables.

470-37017 Aeronautical and Astronautical Engineering. Aircraft Simulation. There are two primary objectives of this project: a.) To find effective computer-oriented algorithms for solving problems involving, and related to, aircraft dynamics (i.e., stability, control, aeroelasticity, etc.); b.) To evolve a package of routines which may be used as instructional aids in several Aeronautical Engineering courses.

471-37018 Civil Engineering. Strain-Compatibility. This problem concerns an investigation of the effect of varying the strain compatibility factor, F, for partially unbonded deep reinforced concrete beams on the moment, curvature and deflection. Numerical integration procedures are utilized in conjunction with strain compatibility and force equilibrium for beam cross-section.

472-37019 Physics. K 2 Gamma. This problem concerns the calculation of Rinematics of π^0 and two gamma decay modes of the K zero Meson, expected counting rates, and analysis of data.

473-37020 Architecture. Structural Analysis. The study of basic methods of solving indeterminate structure as applied to computers. The structural solutions will consist of a number of component parts each solved separately. Then by combining results the total structural solution will be arrived at.

474-37021 Music. An Investigation of the Relationships of Selected Factors to the Musical Achievement of Music Education Majors. The problem involves the determination of relationships existing between performance scores on the Aliferis Music Achievement Test-College Midpoint Level (three sections and total) by 325 college music education majors and several other factors. Those factors include: (1) the major performing medium, (2) amounts of pre-college private study on voice or an instrument other than piano, (3) amounts of pre-college private study on piano, (4) semester hours of music theory, (5) music theory grade point average, (6) semester hours of music courses other than theory, (7) grade point average of music courses other than theory, (8) total college grade point average, and (9) existence of pre-college private study on an instrument or voice alone, piano alone, or both. Some of the comparisons will be made including all subjects and some with only Freshmen or Seniors. Methods to be used are analysis of variance and correlation.

475-37025 Mathematics. Numerical Taxonomy. Measurements of a set of characters from several species of related plants will be used to compute pairwise discriminant indices, using a modified version of Mahalanobis' generalized distance procedure.

476-37026 Chemistry and Chemical Engineering. Jahn Teller Effect. The purpose of the research is to determine the factors which affect the geometrical arrangement of ligands about a central metal ion, and to explain why a given system will come to equilibrium with a particular distorted configuration. Spectral properties and the results of structural studies will be used in the description. For the solution of this problem it will be necessary to solve a number of symmetrical real matrices for which the standard library routine EIGN will be used.

477-37027 Law. Illawtriev. It is planned to use the 7090 to retrieve legal cases by the use of normal legal research Methods. The only difference will be that the number of requirements established by the researcher will be more exacting, and the number of cases searched by the machine will be numerically larger.

It is hoped that this research will result in the discovery of retrieval methods which can be adapted for use by practicing lawyers to assist them in the preparation and consultation of cases.

The contents of 5,000 law cases have been placed verbatim on magnetic tapes; the researcher will define the problem so that cases with similar facts and legal principals will be retrieved by the machine.

478-37028 Psychology. Training of Originality. A word association procedure with six instructional variables is used to train subjects to be original. This is followed by several tests of originality. Sixteen variables are involved for each of the six instructional groups: a pre-test and fifteen originality measures. Covariance and correlation matrices, means, and standard deviations will be used to determine the importance of any pre-training subject variables, the differential effects of the six instructional variables as indicated by the originality tests, and the degree to which these tests measure the same dimension.

479-37030 Theoretical and Applied Mechanics. Inelastic Behaviour. The problem consists of calculating stresses produced and displacements of a thickwalled cylinder under inelastic conditions of behaviour.

The main purpose of this program is to obtain numerical data for a specific problem with various values of loads.

Only standard library routines are employed. The process requires a numerical integration.

480-37031 Mechanical Engineering. Transient Fluid Flow. Transcient solutions of viscous incompressible fluid flow through rectangular ducts.

Numerical data for velocity distributions, mass flow rates and energy dissipation rates are needed.

481-37034 Chemistry and Chemical Engineering. Molecular Weight Determinations. This problem concerns the standardization and application of light scattering methods in the determinations of staph antigen. From data obtained an equation with 7-10 unknowns is constructed which, when plotted against concentration, apprcaches $\frac{1}{M.W.}$ as the concentration approaches zero.

482-37035 Civil Engineering. Spherical Model (Visc. Damping). A continuous medium is simulated by means of springs connecting concentrated masses in a spherically symmetric form consistent with the laws of the theory of elasticity. The model is subjected to a spherically symmetric dynamic load. By means of N. M. Newmarks "method of Beta integration" the acceleration, velocity, and displacement of each mass point are determined numerically for successive time increments. The purpose of this problem is to study the effects of viscous damping on the behavior of the model. The damping effects are simulated by means of dashpots introduced into the model.

483-37036 Education. Learning Manual Skill. Two groups of subjects were given identical learning tasks. Time of instruction was varied. Each group performed a timed and untimed test task.

Standard scores, means, and standard deviations required to do "t" test will be calculated.

Correlations between test scores and other data scores will be calculated.

484-37037 Zoology. Crayfish Methabolism. This problem concerns the analysis of data on metabolism of a cave crayfish. The object of the research is to determine whether a circadian (about a day) rhythm of metabolism is present in an animal that lives in constant darkness.

Hourly observations of metabolism were made on ten different animals of which five were male and five female. The experiment lasted for 15 days, and the metabolism of each animal was recorded about 30 times or twice each day. Observations were not recorded from any animal during all 24 hours of the day. However, most animals were recorded more than once during some hours over the 15 day period.

Least squares is the method used in analyzing this data. The 7094 will be used in comparing the metabolism of each crayfish at different hours of the day and variation during the hours recorded. In addition, the metabolism between sexes will be compared.

485-37038 Mechanical Engineering. Minor Heat Transfer Problems. The programs to be submitted under this number are concerned with the calculation of the effective, internodal resistances for a relaxation grid.

486-37039 Psychology. Interrelationships of Personality Inventories.

The aims of this study are:

(1) to factor analyze a set of personality scales (16PF);

(2) to project into this factor space certain other personality scales, namely, the Minnesota Multiphasic Personality Inventory and the Maudsley Personality Inventory (scores N and E).

The methods will be:

(a) intercorrelation of the 16 PF personality scales;

(b) extraction of principal factors from the matrix of intercorrelation;

(c) analytic rotation (Varimax, Oblimax, Binormamin) of factors;

(d) projection of remaining variables into this space, using the Dwyer extension method.

487-37040 Business Administration, Graduate School. Refinery Simulation. The research problem will involve constructing a mathematical model of a refinery. This model will describe the production capabilities of the refinery and the possible alternative product mixes. Hopefully, this model can be formulated in the format of linear programming, but if non-linearities exist, a simulation technique will be used. Using this model and various environmental conditions to which a refinery is subjected, the IBM 7094 will be used to carry out the computation for optimum refinery behavior. A primary behavioral aspect of refinery operations which will be studied extensively is the time path of output for the major petroleum products. The model plus the computed optimal behavior will then be used to make an economic analysis of the refinery industry, comparing the computed optimal with the actual behavior of firms.

488-37041 Electrical Engineering. Space Charge Regions. This problem involves the solution of second order differential equations by the Runge-Kutta Method.

489-37042 Psychology. Dimensions of Group Products. Factor Analytic investigation of the intrinsic description dimensions on which verbal group products vary. The 7094 will be used in data matrix manipulations and for the actual factor analyses.

490-37043 Agricultural Engineering. Four Bar Linkage Analysis. The problem is to write a subroutine to generate the angular velocities and accelerations of all links of a four bar linkage.

The subroutine will be used in force analysis of four bar linkage.

491-37044 Mathematics. Compiler Techniques. At least two projects will be attempted: The first is an investigation into the problem of translating from one language to another. (Such as from FORTRAN to ALGOL.) The second will be an attempt to write a simplified, inefficient compiler or an interpretive compiler.

MAD will be used because of its ability to handle alphabetic data and because of its speed of compilation.

492-37045 Psychology. Number of Factors. Inclusion of random variables, made up of random normal deviates, in factor analytic studies for the purpose of determining the number of factors to retain and interpret will be studied. The IBM 7094 will be used to generate the random normal deviates and to compute the intercorrelation matrices, the principal axes factors, the varimax rotations and the oblimax rotations of these factors.

493-37046 Chemistry and Chemical Engineering. Internal Rotation. The microwave spectra of several asymmetric top molecules with internal rotation are being investigated. The potential barrier to internal rotation and quadrupole coupling constants for each molecule axe to be calculated. The 7094 is used to carry out the calculation of the rotational energy levels, transformation coefficients, transition frequencies, line strengths, and quadrupole settings. The rotational energy matrix is generated in the symmetric rotor basis and diagonalized to obtain the eigenvalues and eigenvectors. The allowed frequencies are calculated and compared with the observed spectra. Barrier, structural, and quadrupole parameters are varied until agreement with the observed spectra is reached.

494-37047 Education. Canonical Correlation. This problem concerns a factor analysis and canonical correlation between six reading variables and twenty-eight personality variables.

495-37048 State Water Survey. Radioactive Rainout. The data will consist of radar echo heights and the corresponding range and azimuth readings. The computer program will convert range and azimuth to x and y-coordinates and plot the corresponding radar echo height on the x, y-plane. Graphical plots of echo heights will be prepared for approximately 3-minute intervals during the storm periods. A maximum height map for entire storm periods will also be prepared.

496-37049 Electrical Engineering. Optical Devices for Millimeter Waves. The problem consists of calculating the radiation patterns of apertures used at millimeter wavelengths, and of calculating lens contours which give various types of aperture distributions.

497-37050 Civil Engineering. Methods of Eleminating Variables. The problem is concerned with the estimation of speed limit. The study will investigate the application of the elemination methods on the observed variables. The regression techniques will be used.

498-37051 Digital Computer Laboratory. Virial Coefficients. The purpose of this calculation is to numerically integrate and plot certain functions related to the virial coefficients of a quantum mechanical system.

499-37053 Chemistry and Chemical Engineering. Rotational Level Calculation. A new technique, flash heating, has been developed which allows the study of high temperature, non-equilibrium systems, with the aid of ultra-violet absorbtion spectroscopy. The resulting spectrograms bear markings whose position and spacing are characteristic of the absorbing species and which generally follow well defined relationships. However, because of the large number of lines observed, treatment of the data has been a tedious, time consuming task. In particular, with the system PbO, where the vibrational-rotational cards overlap one another, complete analysis of the spectrum has been heretofore impossible, although many able researchers have tried. A new approach to this problem calculating the expected spectrum and comparing with that observed, may enable this problem to be solved. The mathematical operations are reasonably simple, but must be iterated 300 times for each band, of which there are nearly 20. The program consists of calculating 3 operators, then using these operators in a series of loops, indexed from 1 to 100, to calculate the expected position of each transition, which is then printed out.

500-37054 Natural History Survey. Hybridization of Four Species of Centrarchidae (sunfishes). This research problem is concerned with the hybridization of four species of Centrarchidae (sunfishes). These four species are Lepomis macrochirus (bluegill), Lepomis microlophus (red-ear sunfish), Lepomis cyanellus (green sunfish), and Chaenobryttus gulosus (warmouth).

Eggs from a single female were divided into twelve samples. Three of these samples were fertilized with sperm from one male red-ear sunfish, three with sperm from one male bluegill, three with sperm from one male green sunfish, and three with sperm from one male warmouth. This procedure was followed using three female red-ear sunfish, three female bluegills, three female green sunfish and two female warmouths.

The per cent of eggs which hatched and the per cent of eggs which developed into normal free-swimming fry were calculated for each sample. The mean hour of hatching was also determined for each sample. The per cent hatch and the per cent normal free-swimming fry were converted to angle degrees to eliminate the bias inherent in comparing per cents in an analysis of variance.

The total number of eggs in each sample was different; consequently, it will be necessary to use the sample egg number as a statistical weight. The IBM 1401 digital computer is not programmed to conduct a weighted standard analysis of variance; however, the 7094 is programmed to conduct such an analysis.

501-37055 Chemistry and Chemical Engineering. Dipole Moments-1. The dipole moment and error of a compound will be calculated from m experimental measurements. The input data contains; m (no. of experimental measurements, including one run on pure solvent), M, (molecular weight of solvent), M_z (molecular weight of compound), M_R (molar refractivity of compound), T (absolute temperature), P_2 (cell constant), $J_{d_{12}}$ (density error limit), J_{ε} (dielectric constant error limit), and for each measurement: weight of empty flask; weight of flask and compound; weight of flask, compound, and solvent; weight of pyconometer and solvent, weight of empty pyconometer; volume of pyconometer; dipole dial reading in air; dipole dial reading of solution.

For each point the mol. fraction of compound, N_2, the density of the solution, d_{12}, and the dielectric constant of the solution ε_{12} are calculated from the input data. From N_{2q}, d_{12q} and ε_{12q} ($q = 1,2, \ldots n$), the quantities B, d_1, ϑ, and ε, are calculated by the method of least squares. These are the slope and intercept of the lines N_2 vs. d_{12}, and N_2 vs. ε_{12}, respectively. Any point further from the line than the allowed error, J, is discarded.

A new line is then calculated omitting the discarded point(s), (I_2), until all points are within the allowed limits, and new values of B, d_1, α, and ε are obtained.

The dipole moment, μ (in Debye's) is given by

$$\mu\ (D) = 0.01281\left[\left\{\frac{(\varepsilon_1 - 1)}{d_1\ (\varepsilon_1 + 2)}\ \left(M_2 - \frac{M_1}{d_1}B\right) + \frac{3M_1}{(\varepsilon_1 + 2)^3 d_1} - M_R\right\} T\right]^{1/2}$$

and the error in μ by

$$J\mu\ (D) = 0.0046\,\frac{M_1}{\mu}\left[\frac{q}{q-2}\ \left\{\frac{\sum^{k}(\Delta \varepsilon_k)^2}{q\sum N_{2k}^2 - (\sum N_{2k})^2}\right\}\right]^{1/2}$$

where $k = 1, 2, \ldots q$

$q = n - I_{2\varepsilon}$

502-37056 Civil Engineering. Dynamic Response of Highway Bridges. This problem is concerned with the development of a method for the analysis of the dynamic response of simple-span, right, multigirder highway bridges when subjected to the action of moving vehicles. The bridge will be idealized as a single beam.

In this study the beam is represented by a series of rigid bars joined by flexible joints. The stiffness of each joint is EI/h, where E is the modulus of elasticity, I the moment of inertia of the cross section and h is the bar length. The mass of the beam is considered to be uniformly distributed along the rigid bars. The effect of inelastic action in the bridge will be incorporated in the analysis to study the behavior of the system when approaching failure.

503-37057 Psychology. Discriminant Analysis. The problem concerns a determination of the contributions of distance, size, hue and texture to judgments of distance by adult subjects. The IBM 7094 will determine the weights of these variables and evaluate the adequacy of predictions based on these weights.

504-37058 Animal Science. Neuroendocrine Control of the Bird Adrenal. The steroid hormone corticesterone as it is secreted by the chicken adrenal into the adrenal vein was measured under certain experimental conditions. The purpose of this research was to ascertain the effects of hypophysectomy and autotransplantation of the pituitary to the kidney capsule on the production of corticesterone at different time periods after treatment. Corticesterone values in µg/100 ml. adrenal effluent plasma, adrenal tests and body weights and comb lengths are the types of data to be analyzed. A statistical analysis using the method of least squares with 27 variables is proposed.

505-37059 Animal Science. Protein Evaluation. This is a study of some of the factors that may influence the apparent quality of protein fed to rats. The specific factors investigated are age, feed intake, and weight of the animals, and the protein concentration in the ration. Apparent protein quality, termed Biological Value, is the dependent variable. The 7094 will be used to fit constants to the independent variables, their squares and cross-products.

506-37060 Civil Engineering. Slabs with Random Supports. Slabs with supports at random locations will be analyzed by a finite. Difference procedure. Approximately 2000 equations will be solved by a relaxation technique. The cathode ray tube recorder will be used to display the results.

507-37061 Chemistry and Chemical Engineering. Multi-Input-Output Control. In designing a controller for multi-input-output servo systems matrix methods can be used. The usual approach involves use of linear differential equations which describe the open-loop behavior of the system. Often, however, systems are significantly non-linear and this design method breaks down.

The purpose of this study is to show that this method can be modified to yield satisfactory control designs for many types of non-linear systems. Essentially, the computer will perform the matrix algebra necessary to do the work. Typically a run would include consecutively handling several matrices (of order 10 or less) for each of perhaps 20 frequencies representing frequency response data for a non-linear system.

508-37062 Digital Computer Laboratory. Histogram. This program will be used to prepare a histogram of an arbitrary set of data read from cards or from the store.

509-37052 Sociology. Role of Police in Social Control. The research problem concerns the measurement of "The Role of Police in Social Control." The study is considered exploratory and survey in nature because of the relative lack of pertinent studies in this area.

With the use of questionnaires and some personal interviewing we are collecting data on a variety of subjects, largely to orient ourselves in this area and identify crucial variables for further study, but also to tentatively arrive at some supportable conclusions that may be made at this time.

The procedure of analysis will be one of seeking out variables and determining their distribution and meaning to not only the police organization, but to the agencies of social control in addition to the police, and to a cross section of the general public in whose communities the police organizations are found.

First, we will want to determine the differences in attitudes of police, other agency workers, and the public among the three communities. From here the differences will be investigated by identification of the related demographic characteristics of the various populations in the study. Within each community the discrepancies between the perception of the role of other agencies will be calculated in the process of plotting the "social control complex" in the community, as well as an indicator of relations between the various components of social control.

Relatively unsophisticated statistical procedure will be required in the initial stages of the data analysis. However, as variables are identified more rigorous methods will be in order.

510-37063 Horticulture. Raspberry Gibberellin. This study is concerned with the effects of varying concentrations of Gibberellic Acid and nitrogen fertilizer upon the growth of raspberry plants. Since nitrogen and Gibberellic Acid applications may effect various parts of the plant in different manners, measurements on the nitrogen concentration (in percent dry weight), and total nitrogen accumulation (in milligrams) were made on several separate tissues as well as entire plants of Purple Autumn raspberries. In addition, the fresh and dry weights of several separate tissues were recorded. These tissues include the leaf blades and petioles, stems, and roots.

The data collected is to be subjected to analysis of variance procedures. The Agronomy Statistical Laboratory "Factorial Analysis of Variance Program" will be utilized to obtain the means, analysis of variance table and individual degree of freedom comparisons. The latter will provide estimates of the main effects and interactions of the nitrogen and Gibberellic Acid levels used.

Instructional Problem Specifications

There were 4 instructional problems submitted during the month of July.

167-37022 Civil Engineering 391. Problem 2. Grade Elevation. Assume that the first task will consist of computing and tabulating grade elevations along a proposed highway profile, consisting of two tangents and a parabolic vertical curve.

Your assignment is to furnish a complete set of instructions, including all required computations and decisions necessary to accomplish this task.

The information available to the aide is as follows:

The starting station, STA 1 (not necessarily equal to zero).

The grade elevation at the starting station, ELEV 1.

The grade, in percent, of the first tangent, G 1.

The grade, in percent, of the second tangent, G 2.

The half-length, in stations, of the vertical curve HL.

The station of the intersection of grades, STAPVI.

The end station, STAEND.

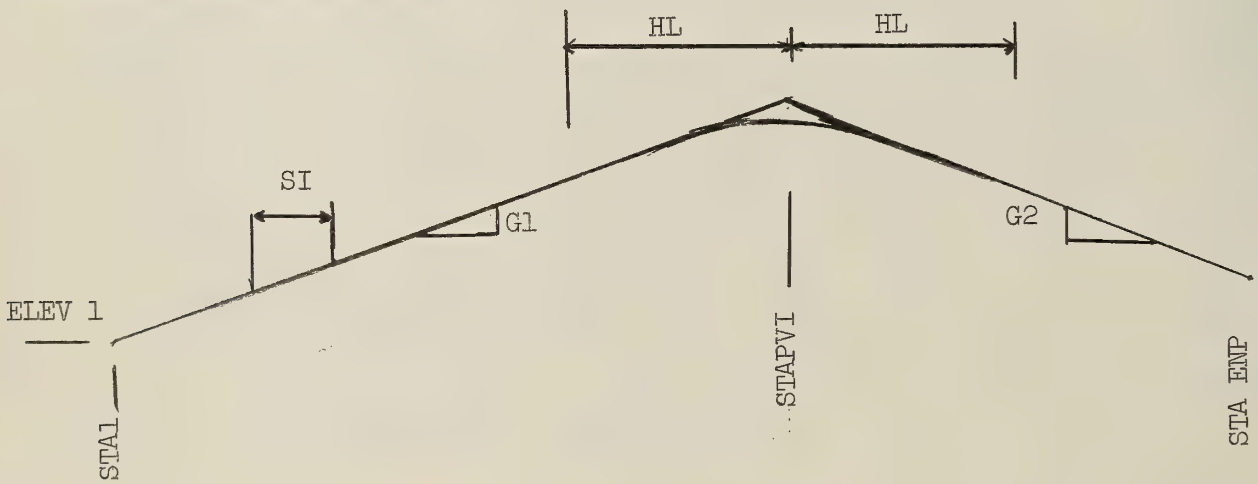
The increment, in stations, at which grades are required, SI.

The aide is to tabulate the results in the format shown:

Column	1	2		
	Station	Elevation on Tangent	Tangent Offset	Grade Elevation (if different from elevation on tangent)
	-------	---------	-----	---------------

It is understood that STA 1, STAPVI, STAEND and HL are multiples of SI, and that STA 1 < STAPVI - HL < STAPVI + HL < STAEND

The sketch below is given for your convenience only. The aide cannot interpret this sketch, and can only follow the elementary rules of algebra and make yes-or-no decisions.



I68-37023 Civil Engineering 391. Problem 3. Maximum Moments. Write a program to compute a curve of maximum moments for a simple beam of span L, produced by a standard AASHO H or H-S load shown below. Note that the third axle, P_3, may or may not be present, and that the truck can face in either direction. The curve of maximum moments is to be generated by subdividing the span into n equal lengths, and evaluating the maximum moment at the points

$$x_i = \frac{i}{n} L, \; l = 1,2,\ldots \frac{n}{2},$$

(i.e., up to midspan).

Note that for each point x_i, the following conditions may exist:

a) only one axle fits on the span

b) one additional axle fits on right, no axle fits on left

  b1) if H-S loading, use P_2 and P_3

  b2) if H loading, use P_2 and P_1

c) one axle fits both on right and left

d) two axles fit on right, no axle fits on left

e) two axles fit on right, one axle fits on left

f) two axles fit both on right and left

Possibilities c through f may have to be further subdivided depending whether an H or H-S loading is used.

The program is to start as follows:

```
1 READ INPUT TAPE 7, 2, SPAN, MPANS, P1, P2, P3, WBSE
```

(SPAN and WBSE in feet; P1, P2, P3 in kips)

Output is to consist of three quantities for each value of l, as follows:

i

x_i in feet

M_i in foot-kips

169-37024 Civil Engineering 391. Problem 4. Special Problem 391. The term projects required for the additional 1/2 unit credit in this course are intended to give the student first-hand experience in developing a complete computer program from its inception to the finished machine program.

In order to facilitate review, it is requested that the term projects be submitted in the format given below. The original term projects will remain in the hands of the instructor. If the papers are not excessive in length, and submitted in a reproduceable form (vellum or ditto master), it will be possible to reproduce them and return a copy to the student.

Please use the same nomenclature for write-up, flow diagram, and program.

All problems will be run under one problem number after approval of format and flow diagram by the advisor.

An outline of the problem including a general flow diagram and a description of the method should be submitted and approved by special problem advisor before November 28 and the completed report must be submitted by January 14.

The suggested format is as follows:

1. Statement of problem. A clear, concise statement of the problem involved, including a general dexcription of the available information (input data), the method by which the computer is expected to solve the problem, and the desired answers (output data).

2. Justification of program. A statement as to why you believe the computer program would be advantageous, in terms of time saving, more precise analysis, etc.

3. Method of solution. A step-by-step development of the method of solution to be used by the program, (with figures where applicable) preferably using the same symbols which will appear in the flow diagram and coding sheets.

4. Assumptions and limitations. List of all assumptions and limitations pertaining to the physical quantities involved in the problem.

5. Input and output data. List and definition of all input parameters involved and output data obtained.

6. Parameter limitations. A listing of the limits imposed on the parameters involved both due to scaling and storage limitations.

7. Extension of computations. If the program pertains only to a portion of a potential computer problem, list the extension that could be made to make the program more general or more useful.

8. Flow diagram. A general flow diagram of the computer process, to take up not more than one page. In addition, detailed flow diagrams of some or all portions of the program are to be included whenever they contribute to the understanding of the problem.

In the case where the term project is carried beyond the flow charting stage, the following items are to be added:

9. Memory allocation. A list of memory locations used for instructions, constants and data. In addition, all subroutines and constants used by the program are to be defined.

10. Method of utilization. A description of the format of input and output data, and of the manner in which the problem is run on the computer. If the term project involves a subroutine, the entry and exit linkages are to be clearly defined.

11. A FØRTRAN listing.

12. Sample problem. Input and output data, annotated if necessary for clarity, for a typical problem solved.

I70-37029 Chemistry 490. Problem 2. 7094 Short Course for Chemists.
Write a function subprogram in SCATRE to evaluate a polynomial in two variables X and Y. The polynomial is of order N in X and M in Y and the coefficients are stored in FORTRAN format.

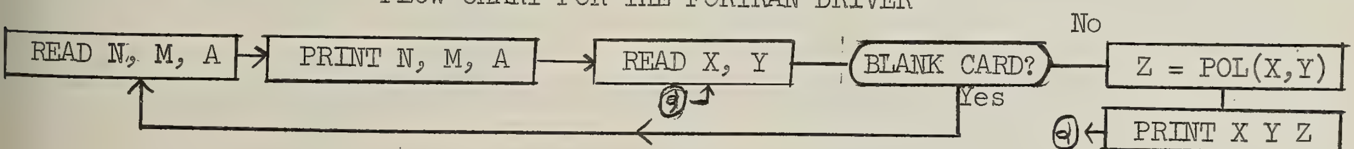
$$z = d_{oo} + a_{o1}x + \ldots a_{on}X^n + a_{1o}Y + a_{,,}YX + \ldots a_{1n}YX^n + a_{21}Y^2 + \ldots a_{mn}Y^mX^n$$

where $A(1,1) = a_{oo}$; $A(1,2) = a_{o1}$; etc.

Carry double precision throughout the computation and round the result to single precision. The calling sequence in FORTRAN should be Z = POL (X,Y,N,M,A,MD) where A appears in a dimension statement A(MD,ND).

Write a FORTRAN driver program which will read N and M from a card (2I3) and the Matrix A, 5 elements per card by rows (5E15.8). Print N,N and the Matrix A. Then read X and Y from a card, and print X, Y and Z. Read another X and Y and repeat until a blank card is encountered. Then start over.

FLOW CHART FOR THE FORTRAN DRIVER



Information on the utilization and reliability of the IBM 1401 and IBM 7094 for the month of July, 1963 is given in the tables below.

TABLE I - IBM 1401

Summary of Use

July, 1963

Scheduled Engineering	-0-
Unscheduled Engineering	4:17
Maintenance	4:11
7094 Preparation	428:02
Listing	19:33
Reproducing	5:24
CDC Preparation	:05
Code Checking	10:17
Tape Tests (regular use tape)[1]	4:58
Tape Tests (special)[2]	16:43
SMP	22:58
Tape Dump	13:36
Tape Duplicate and Compare	2:03
Miscellaneous Operations	:30
Idle	21:52
	554:29

[1]Test made on tapes in use to check for any damage or wear.

[2]Test made on special experimental tape to determine the durability and reliability of tape.

TABLE II - IBM 1401

Summary of Machine Errors

July, 1963

1401 Main Frame	1
1402 Reader-Punch	2
1403 Printer	6
729 V Tape Units	4
	13

TABLE I - IBM 7094

Summary of Use

July, 1963

Scheduled Engineering	34:10
Unscheduled Engineering	56:16
Air Conditioning	:55
Production	572:45
System Updating	1:37
Operator Manipulation	78:36
	744:19

TABLE II - IBM 7094

Summary of Machine Errors

July, 1963

Arithmetic Unit	13
729 VI Tape Units	5
C.R.T.	2
Disk File	1
716 Printer	1
	22

TABLE III - July, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURE	IBM 1401 DAILY TIME DISTRIBUTION
7/1/63	13:30		3:00			16:30	1	(1) 1402 card read-punch will not read cards. Contact strap broken and replaced.
7/2/63	23:10			:15	:35	24:00		
7/3/63	22:25				1:35	24:00		
7/4/63	17:14					17:14		
7/5/63	15:10			:20	:30	16:00		
7/6/63	6:21					6:21		
7/7/63	:55					:55		
7/8/63	14:15		1:45			16:00	1	(1) Power failure from main power outlet on 1401. Emergency off switch had been pulled.
7/9/63	21:57				2:03	24:00		
7/10/63	23:09			:10	:41	24:00	1	(1) Tape head stuck in down position. Released by engineers.
7/11/63	21:04			:15	2:41	24:00	1	(1) Tape unit B does not rewind properly. Loose pulley on motor found.
7/12/63	23:16			:30	:14	24:00	1	(1) Tape unit B will not rewind. Trouble not found.
7/13/63	6:54					6:54		
7/14/63	3:00					3:00		
7/15/63	16:00			:15	7:45	24:00		
7/16/63	23:20			:15	:25	24:00	1	(1) 1403 printer randomly does not print in Column 69. Trouble disappeared.
7/17/63	21:29		2:00		:31	24:00	3	(1) 1403 printer misses printing characters in Column 70. Trouble disappeared. (2) Tape unit B does not unload properly. New residual was put in. (3) Continuous carriage runaway. Trouble disappeared.
7/18/63	23:34			:16	:10	24:00	1	(1) Continuous carriage runaway. Trouble disappeared.
7/19/63	22:30				1:30	24:00	1	(1) Continuous carriage runaway. Trouble disappeared.
7/20/63	13:18				:37	13:55		
7/21/63	4:50					4:50		
7/22/63	15:23		:17	:20		16:00	1	(1) Reader will not read properly. First card lever points replaced.

TABLE III (CONTINUED)

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURE	IBM 1401 DAILY TIME DISTRIBUTION
7/23/63	24:00					24:00		
7/24/63	24:00					24:00		
7/25/63	23:45			:15		24:00		
7/26/63	24:00					24:00		
7/27/63	15:30					15:30		
7/28/63	:20					:20		
7/29/63	13:05			:35	2:20	16:00		
7/30/63	23:00		:15	:45		24:00	1	(1) 1403 printer paper advance mechanism is out of adjustment. The lower right forms tractor was found to be bent.
7/31/63	23:45				:15	24:00		
	524:09	-0-	4:17	4:11	21:52	554:29	13	

TABLE III - JULY, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANIP-ULATION	TOTAL RUNNING TIME	FAILURE	IBM - 7094 DAILY TIME DISTRIBUTION
7/1/63	21:24	2:55				24:19*		
7/2/63	17:49				6:11	24:00	1	(1) Left reel hub on tape unit U will not engage. Brush found to be burned.
7/3/63	11:02	2:00	8:00		2:58	24:00	3	(1) Diagnostic tests failed to run. Defective SMS card found in 7110. (2) Power kicked off on multiplexor. Reset multiplexor and trouble disappeared. (3) Tape unit S will not unload. After working with it for awhile, trouble disappeared.
7/4/63	23:27				:33	24:00		
7/5/63	18:53	2:00	:45		2:22	24:00	1	(1) Diagnostic routines are failing.
7/6/63	12:00		12:00			24:00	1	Same trouble as above continues. (1) Fuse blew and was replaced.
7/7/63	24:00					24:00		
7/8/63	18:57	1:30			3:33	24:00		
7/9/63	17:49	2:00	:31		3:40	24:00	1	(1) Power check on multiplexor. Engineer reset multiplexor and trouble disappeared.
7/10/63	17:20	2:10	:10		4:20	24:00	1	(1) Power check on multiplexor. After multiplexor was reset, trouble disappeared.
7/11/63	15:12	2:45	1:53		4:10	24:00	2	(1) Continuous power checks on multiplexor. Engineers found loose pin to thermal card and replaced thermal card. (2) Tape unit S on Channel B will not unload nor write. Sticky capstan motor which the engineers oiled and in general went over. Trouble disappeared.
7/12/63	16:19	4:00			3:41	24:00		
7/13/63	23:35				:25	24:00		
7/14/63	24:00					24:00		
7/15/63	18:43	2:15			3:02	24:00		Engineers writing format on disk file.
7/16/63	18:17	1:10			4:33	24:00	1	(1) Power check on multiplexor. Engineer reset.

TABLE III - (Continued)

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANIP-ULATION	TOTAL RUNNING TIME	FAILURE	IBM 7094 DAILY TIME DISTRIBUTION
7/17/63	16:28	1:35	2:35		3:22	24:00	1	(1) Continuous power checks on multiplexor. Engineer found no trouble and reset.
7/18/63	18:38	1:40			3:42	24:00	1	(1) Tape unit R will not load tape. Trouble not found.
7/19/63	15:54	1:30	3:05	:55	2:36	24:00	1	Hole made in floor under multiplexor in order to get a bigger air flow through the multiplexor. (1) Power check on Channel A. Engineer suspected ground loop but trouble disappeared.
7/20/63	23:37		:15		:08	24:00		
7/21/63	24:00					24:00		
7/22/63	20:22	:30			3:08	24:00	1	(1) Double precision floating point divider reported to be not working properly. Trouble not found.
7/23/63	18:53	1:25			3:42	24:00	1	(1) CRT not working properly. It advanced through complete roll of film.
7/24/63	19:19				4:41	24:00	2	(1) CRT display not functioning properly. (2) Tape unit R didn't unload properly.
7/25/63	19:06	:15			4:39	24:00		
7/26/63	16:32	2:30	1:15		3:43	24:00	1	(1) Double floating subtract not working. No error found by engineers.
7/27/63	23:06				:54	24:00		
7/28/63	24:00					24:00		
7/29/63	8:00	2:00	14:00			24:00	1	(1) Double precision arithmetic will not work properly. Engineer found shorted card on 7/30/63.
7/30/63	11:41		11:45		:34	24:00	1	(1) When restarting job, computer goes into a loop. Trouble not found.
7/31/63	15:59		:02		7:59	24:00	1	(1) Printer developed "squeak" and was greased.
	574:22	34:10	56:16	:55	78:36	744:19*	22	

* Due to fact we cannot always update the system at exactly midnight.

TABLE IV - IBM 7094
USE BY DEPARTMENTS - JULY, 1963

DEPARTMENT	Number of Runs			Total Number of Runs	Number of Problem Specifications			Total Number of Prob. Spec.	Time Used			Total Time Used
	Class	Research	Non System		Class	Research	Non System		Class	Research	Non System	
Aeronautical and Astronautical Engineering		56		56		3		3		:48		:48
Agricultural Engineering		94		94		4		4		1:31		1:31
Agricultural Economics		108	11	119		7	3	10		3:18	5:56	9:14
Agronomy		122		122		11		11		:58		:58
Animal Science		7		7		1		1		:34		:34
Architecture		48		48		1		1		:23		:23
Astronomy		15		15		3		3		:07		:07
Bureau of Economic and Business Research		27		27		2		2		:38		:38
Bureau of Educational Research		5		5		1		1		:50		:50
Civil Engineering	504	1079		1583	4	39		43	4:32	56:52		61:24
Chemistry and Chemical Engineering	73	1126		1199	2	38		40	:34	44:18		44:52
Communications		6		6		1		1		:35		:35
Digital Computer Laboratory	65	777	81	923	1	16	5	22	:46	12:53	311:49	325:28
Dairy Science		30		30		1		1		:21		:21
Economics		4		4		1		1		:11		:11
Education		47		47		6		6		1:34		1:34
Electrical Engineering	5	446		451	2	15		17	:08	7:43		7:51
Forestry		36		36		2		2		1:17		1:17
Food Technology		10		10		2		2		:08		:08
General Engineering		4		4		1		1		:04		:04
Geology		1		1		1		1		:14		:14
Horticulture		3		3		1		1		:01		:01
Institute of Communications Research		29		29		2		2		:45		:45
Industrial Engineering	44			44	1			1	:54			:54
Institute of Government and Public Affairs		1		1		1		1		:01		:01
Instructional TV		30		30		3		3		1:07		1:07
Institute for Research on Exceptional Children		6		6		2		2		1:17		1:17
Law		4		4		1		1		:23		:23

TABLE IV (CONTINUED)

DEPARTMENT	Number of Runs: Class	Number of Runs: Research	Number of Runs: Non System	Total Number of Runs	Number of Problem Specifications: Class	Number of Problem Specifications: Research	Number of Problem Specifications: Non System	Total Number of Prob. Spec.	Time Used: Class	Time Used: Research	Time Used: Non System	Total Time Used
Mechanical Engineering	1	441		442	1	14		15	:01	9:38		9:39
Mining, Metallurgy and Petroleum Engineering		167		167		4		4		2:39		2:39
Men's Residence Hall Association Rocket Club		31		31		1		1		3:26		3:26
Music		4		4		1		1		:03		:03
Nuclear Engineering		124		124		2		2		2:29		2:29
Office of Instructional Research		56		56		1		1		:26		:26
Physics		1064		1064		25		25		26:50		26:50
Physiology	2	3		5	1	1		3	:01	:09		:10
Psychology		458		458		26		26		21:17		21:17
Sociology		28		28		1		1		:23		:23
Statistical Services Unit		379	2	381		2	1	3		10:30	:55	11:25
State Water Survey		104		104		9		9		3:35		3:35
Theoretical and Applied Mechanics		238		238		9		9		5:30		5:30
Zoology		1		1		1		1		:04		:04
Sub Total	3672	7246	94	11012	14	266	9	290	27:05	226:00	318:40	571:57
Instruction		60		60		1		1		:48		:48
Grand Total	3672	7306	94	11072	14	267	9	291	27:05	226:48	318:40	572:45

PART V

GENERAL LABORATORY INFORMATION

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	16	0	16.0
Visiting Faculty	4	0	4.0
Research Associates	4	1	4.5
Graduate Research Assistants	23	15	30.7
Graduate Teaching Assistants	0	1	0.5
Professional Personnel	3	0	3.0
Administrative and Clerical	7	0	7.0
Other Nonacademic Personnel	48	52	79.0
TOTAL	105	69	144.7

The computer Advisory Committee Consists of Professors H. C. Brearley, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During July a total of 59 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	2	1
Medium Drawings	7	0
Small Drawings	2	1
Reports	29	0
Change Orders	9	0
Printed Circuits	0	3
Miscellaneous	3	2
TOTAL	52	7

Most of the drafting time in the Pattern Recognition Computer section has been used in developing circuitry layouts and printed-circuit board layouts for feasibility and not for actual manufacturing purposes.

(K. C. Law, P. Richardson)

Contract Accounts

As of July 31, 1963

Title and Code Number	US AEC 415 46-46-15-303	US AEC 1018 46-26-15-304	US NSF G16489 46-26-15-358	US ONR 1834-15 46-26-15-360	US ONR 1834-27 46-26-15-361	US NSF G16489 (Summer Program) 46-88-55-818
Ledger Balance Previous Month,	209,708.41	316,617.96	36,716.34	11,369.27	1,730.48	5,160.00
Salaries and/or Wages	24,915.20	16,634.17	5,911.08	3,939.05	1,666.66	-0-
Ind. Cost	13,703.36	9,148.79	1,380.61	2,284.65	966.66	-0-
Retirement	1,372.28	717.24	526.86	149.99	161.28	-0-
Workmen's Comp.	132.82	166.73	59.11	39.39	16.67	-0-
Supplies and Expenses	16,609.07	11,573.75	1.30	57.86	-0-	-0-
Equipment	533.92	5,889.33	-0-	-0-	-0-	-0-
Travel	85.05	1,181.52	404.71	-0-	-0-	-0-
Total Monthly Expenditure	57,351.70	45,311.53	8,283.67	6,470.94	2,811.27	-0-
Transfer (Credit or Debit)	-0-	-0-	-0-	-0-	-0-	-0-
Ledger Balance	152,356.71	271,306.43	28,432.67	4,898.33	-1,080.79	5,160.00
Enc. Supplies and Equip. Only	148,461.81	79,735.26	-0-	1,995.03	-0-	-0-
Free Balance	3,894.90	191,571.17	28,432.67	2,903.30	-1,080.79	5,160.00
Termination Date	Aug. 31, 1963	Nov. 30, 1963	March 1, 1964	Aug. 31, 1963	June 30, 1963	March 1, 1964

Accounts Other Than Contracts

As of July 31, 1963

Title and Code Number	Grad College Digital Comp. 00-26-15-300	IC Digital Computer 40-26-15-300	IC Digital Computer-Taub 41-26-15-382	IC Dig. Comp. 7090 Rental 40-26-15-316	Service Grad 7090 Service 15-26-15-990	TR: 7090 Purchase 60-26-15-360	IBM Corp. Comp. Expansion 44-26-15-340
Ledger Balance Previous Month	2,266.50	61,276.57	4,334.95	17,479.20	-25,468.84	-49,317.72	37,128.49
Salaries and/or Wages	162.03	360.75	2,561.09	-0-	4,904.43	-0-	1,925.30
Supplies and Expenses	891.99	881.95	-0-	5,768.74	9,474.98	-0-	19.25
Equipment	135.53	2,454.49	-0-	-0-	275.00	-0-	-0-
Travel	132.80	123.63	-0-	-0-	-0-	-0-	-0-
Total Monthly Expenditure	1,322.35	3,820.82	2,561.09	5,768.74	14,654.41	-0-	1,944.55
Credit or Debit to Account	(C) 41,900.00	-0-	-0-	-0-	(C) 2,804.80	-0-	-0-
Ledger Balance	42,844.15	57,455.75	1,773.86	11,710.46	-37,318.45	-49,317.72	35,183.94
Encumbered (Supplies and Equipment Only)	288.31	8,997.31	-0-	2,622.41	14,130.14	710.00	-0-
Free Balance	42,555.84	48,458.44	1,773.86	9,088.05	-51,448.59	-50,027.72	35,183.94

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM

PART II - ILLIAC II SYSTEM PROGRAMMING AND OPERATION

PART III - CIRCUIT RESEARCH PROGRAM

PART IV - SWITCHING THEORY

PART V - IBM 7094-1401 SYSTEM

PART VI - GENERAL LABORATORY INFORMATION

AUGUST 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction

In terms of transistor counts the following progress has been made during August.

Chassis wired	664
Chassis changes	89
Printed circuits	1,046 (173 cards)

In addition, the following corrective efforts were made on card circuits:

Repairs	12 cards
Engineering changes	21 cards
Modifications	51 cards

(T. Kerkering, F. Serio)

2. Magnetic Drum Memory

Four two-bit chassis of read-write electronics were completed during the month. This completes the chassis construction for the drum, except for modifications and one spare read-write chassis. In order to use these chassis, the remaining ten columns of heads on drum 129 were adjusted. In the process, one head touched the rotor, ruining head A12, and tracks Ø11, P11, A12, and B12. These heads were retracted. Some heads were also removed because of unusually high or low inductance. To make up for these losses, spare heads and tracks were wired into the 14 drum connectors to form a complete 32,768-word memory.

Two drum test programs have been written and used extensively. The first one (Drum Transfer Check, P1-DTC-52ν) writes and reads fixed-data patterns on all drum blocks, and prints out errors. The second (Random Number Drum Test, P1-RDT-54ν) is a variation on an earlier program which checked the 1401 connection. It writes and reads 256 word blocks of random data on the drum, and prints out errors. As a result of these tests many adjustment and some design changes were made to the electronics. Some of these changes have been incorporated in the chassis; some remain to be done.

The drum manufacturer has proposed to convert our fixed-head drum to flying heads for improved performance and reliability. Part of the impetus for this change is the experience we have had scraping tracks. On drum 129 we have lost three, seven and four tracks in three accidents. The drum manufacturer lost three tracks on drum 128 in preparing to ship it after overhaul. The other impetus for this change is the markedly improved performance and reliability of their flying heads, some of which have been in customers' hands since July 1962, but which were not available at the time of our 1961 procurement.

To evaluate this further, a visit was made to the manufacturer's plant on August 21. A 10-inch, 3,600-rpm drum was running with flying heads. The heads were mounted in pads of eight, and were advanced to operating position by a bimetallic strip and a heater. Resolution was in the 0.9 to 1.0 range, which is very much better than the .5 to .6 of our fixed-head drums. Amplitude modulation was quite small because the heads followed the once-around runout. A formal proposal is expected from the manufacturer.

(H. C. Brearley, J. Bouknight,
G. E. Cooper, M. D. Freedman, R. L. Miller)

PART II

ILLIAC II SYSTEM PROGRAMMING AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Computer Use

Engineering Tests		
ETR	1:27	
Duplex Memory	:25	
Memory Reversing	:10	
DAMN	48:57	
BTC	14:08	
		65:07
Computer Engineering		
General Maintenance	88:18	
Drum Engineering	48:08	
Interrupt Engineering	45:56	
Interplay Engineering	27:14	
1401 Channel Engineering	23:15	
		232:51
Code Checks		64:11
Math 001		81:59
NICAP Assembly Work		62:14
Demonstrations		3:16
*Idle		35:47
*Power Off		7:30
Production		
Jordan	126:15	
Gillies	64:50	
		191:05
TOTAL TIME IN USE		744:00

*Not included in engineering periods.

2. Component Failures

Transistors		
Spontaneous	7	
Induced by other failures	1	
Caused by accident	1	
		9
Zeners		
Spontaneous	1	
		1
Diodes		
Spontaneous	2	
		2
Capacitors		
Spontaneous	7	
		7
Resistors		
Spontaneous	1	
		1
AC Master Turn-on Switch	Shorted	1
TOTAL COMPONENT FAILURES		21

3. Computer Failures

Reader		4
Punch		9
I/O System Failure		1
Parity		
Reader-punch	1	
Core	3	
		4
Core Power Failure		4
Main Frame Power Failure		3
Unknown		2
TOTAL FAILURES		27

(W. L. Huffman)

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

It was felt during the last months that a better knowledge of the optical transmission of information is desirable. In view of this a tentative program was established to look into the following areas:

(a) Light modulators.

(b) Logic using multilevel lasers.

(c) Electronic circuits controlling junction lasers and being controlled by photodiodes.

Gabor Ujhelyi and Sergio Ribeiro report on some of the light-modulator work below.

The study of avalanching has led Louis van Biljon to an investigation of microplasms. It appears that potentially the use of such localized discharges could lead to reversible switching in the subnanosecond region.

2. Light Modulators

Electro-Optical Light Modulator

We have constructed and tested a device in which the light beam travels inside a glass plate, being reflected about 20 times between the two interfaces with nitrobenzene. The electrodes were arranged in such a way that both surfaces had controlled reflectivity. (See Fig. 1).

With pulses of nine kilovolts the percentual modulation was respectively 22 percent and 11 percent for normal and parallel polarization of the light beam with respect to the place of incidence, with no visible high-frequency drop.

The relatively low modulation efficiency obtained is caused by an undue curvature of the input surface to the glass plate, which causes a considerable spread of the collimated light beam. This surface is being repolished to solve the difficulty.

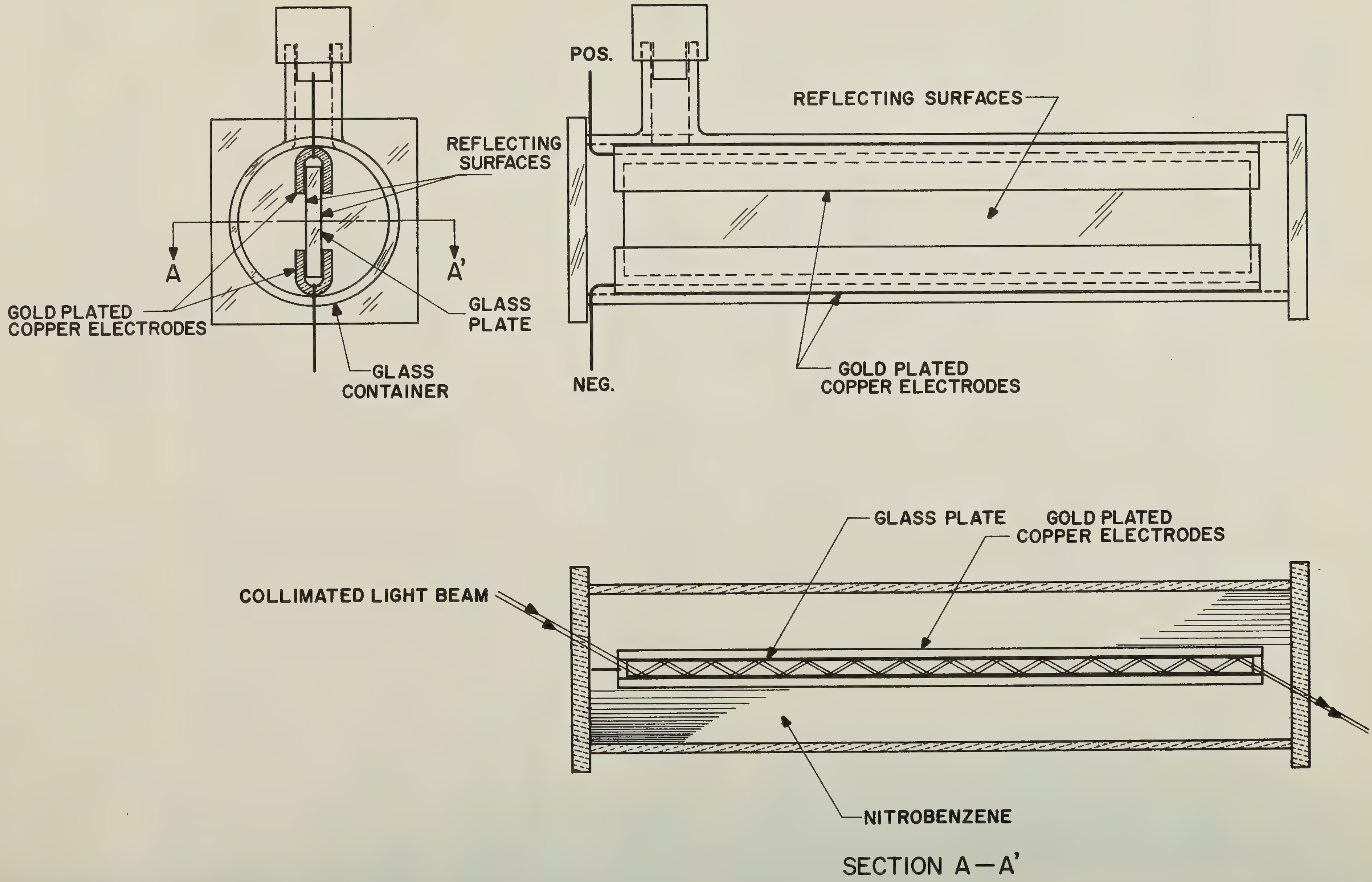


FIGURE 1 LIGHT MODULATOR

Considering that the radius of curvature of this defective surface was only 15 cm, the modulation obtained should be considered quite good.

The Light Beam Bending Experiment

It is known from physical optics that a gradient of index of refraction (grad n) causes a beam of light to bend toward the region of higher index of refraction (n). An experiment was performed (see Fig. 2) where grad n was established by an electric field acting on nitrobenzene. A 7 cm long pair of electrodes (placed 0.5 mm apart) had a "fringe" electric field (E) in the surrounding nitrobenzene; this field had a high gradient of E close to the electrodes. This grad E gave rise to a grad n due to the electro-optical effect in the nitrobenzene. The experiment consisted in aiming a well collimated, narrow light beam through the high grad n region and the deflection of the beam due to the imposed voltage was observed by means of a movable pinhole. A maximum deflection of over 0.003 radian was observed at 5 kv.

3. Avalanche Breakdown

Detailed observation of base-collector breakdown characteristics on many transistors have lead to the following conclusions:

Together with electric field in the base, and base-width modulation, multiple localized breakdowns (microplasmas) are a major factor in causing the inherently "soft" breakdown of transistors, as had been observed in diodes.

Fast switching with transistors (i.e., "on" and "off" rise times each less than 10^{-9} seconds) will be feasible if these microplasmas can be accurately controlled. Single microplasmas carrying no more than a few microamperes will be required at breakdown voltages of 30 volts of less; inherent junction capacitances otherwise limit the speed of operation.

Although extremely fast single current pulses are obtainable with transistors by making use of microplasma formation, the results as yet are not reproducible. This may be due either to changing characteristics of the breakdown region or an inherent randomness in microplasma initiation.

The more obvious theoretical problems to be solved are:

1. Is microplasma formation solely a function of field strength or does it require an added outside ionizing agent? Can its formation be willfully controlled?

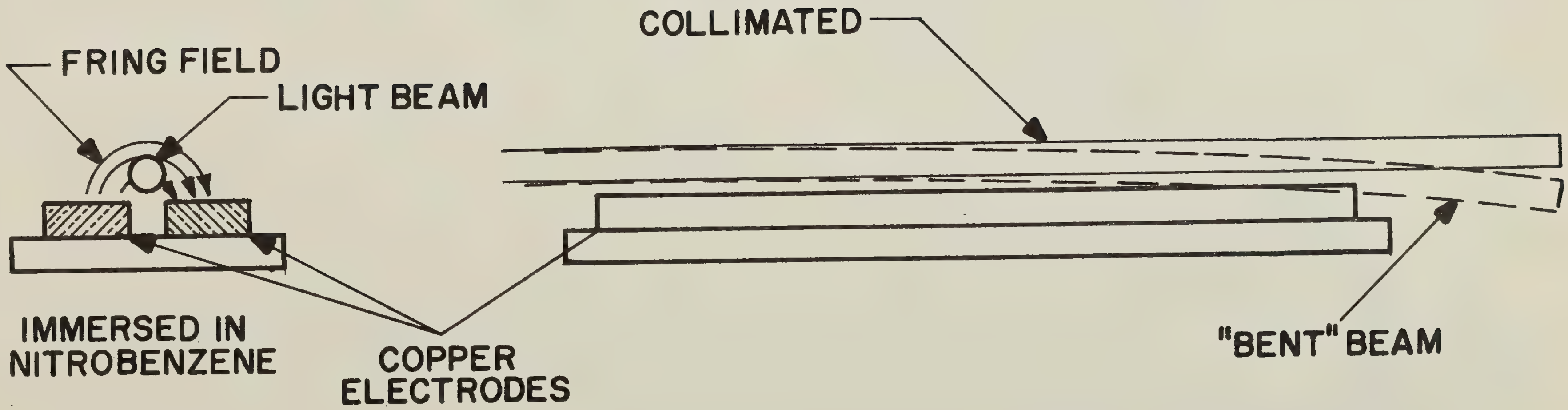


FIGURE 2. BEAM BENDING EXPERIMENT

2. Why does it have such a small, well defined cross section in spite of extreme current density, and in spite of its radiating high energy photons which could serve as ionizing agents for neighboring regions?

3. Is there a minimum current or current density for sustaining the breakdown?

4. What are the relations between minimum required field strength, ionizing potential and mean free path?

5. Is a microplasma inherent different from a uniform, larger discharge?

6. Is the accompanying radiation due solely to recombination or also the result of electron acceleration in strong Coulamb fields?

On the experimental side the one main difficulty remains the faithful display of the extremely sharp current pulses characterizing the above phenomena.

PART IV

SWITCHING THEORY

(Supported in part by the Office of Naval Research under Contract Nonr-1834(27).)

Mr. W. Donald Frazer has completed his doctoral thesis on bilateral threshold nets. The following is an abstract of his thesis.

"Extant theories of logical design conventionally make several assumptions regarding the characteristics of the logical elements used in forming networks; among the most fundamental of these is that of directivity of information flow. This assumption has historical basis in the fact that most of the devices used heretofore in the construction of logical elements have been three-terminal devices. The growing number of two-terminal bistable devices--networks of which are basically nondirective with respect to information flow--has created new problems associated with the artificial imposition of directivity, and thus raised the question of whether one might profitably revise one's concepts of logical design to conform to the characteristics of such devices.

"It is the object of this thesis to initiate a theory of logical design for networks in which information is not constrained to flow in only one direction along a connection between devices. A linear graph model is proposed for a very general class of such "nets": To each vertex (i) of a linear graph is assigned an ordered pair (z_i, k_i), where $z_i = \pm 1$ is called the "state" of vertex i and k_i is an integer called the "threshold" of the vertex. A connection matrix, A, is also defined: a_{ij} represents the weighted bilateral connection between vertices i and j. The "next" or "desired" state of vertex i is defined by a function $F[\sum_j a_{ij} z_j - k_i]$ where $F[x] = +1$ $(x \geq 0)$ and $F[x] = -1$ $(x < 0)$.

"A method of analysis based on this model is proposed for learning the state behavior of nets, and a canonical form for any net proposed. It is demonstrated that, under very general assumptions, any net of this kind must proceed from any initial state to an equilibrium state, and a bound is given on the number of vertex state changes which can take place in such a transition. Results are presented which describe the characters of the stable states of such nets and place bounds on the number of such states.

"Approaching the problem from a more conventional point of view, one can define a family of functions which expresses the state behavior of any vertex in the net as a Boolean function of the states of the other vertices and of the inputs. This family of functions is shown in this case to have a structural property called "pairwise monotonicity," a generalization of the usual concept of Boolean monotonicity to families of functions. It is demonstrated that this property and its extensions play a major role in determining logical design techniques for nets of this kind; they make it impossible, for example, to simulate any directed logical net having feedback.

"The presentation concludes with a discussion of the synthesis of bilateral threshold switching nets. It is demonstrated that all "idempotent automata"--automata incapable of distinguishing the single input "a" from the input sequence "a followed by a"--are realizable as nets of this type, and two schemes are given for achieving such realizations. The possibility of development of synthesis techniques capable of achieving more general net topologies than those resulting from the two schemes mentioned above is also discussed, and shown not to be feasible with present knowledge of the theory of threshold logic."

Mr. Frazer's thesis has been prepared as Laboratory Report No. 153.

PART V

IBM 7094-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

NEW ROUTINES

B3-UØI-DEX1-41-SR

Double Precision Floating Point Exponential SCATRE, FØRTRAN, MAD. This program computes in double precision floating point 2^x, e^x, or 10^x where x is a double precision floating point number.

For 2^x, $x < 128$. For e^x, $x < 88.7228391$. For $10^x, x < 38.5318394$. If the above inequalities are violated an error message will be printed. The argument x need not be normalized. For 2^x, if $x < -129$, $2^x = 0$; for e^x, if $x < -129\log_e 2$, $e^x = 0$; for 10^x, if $x < -129\log_{10} 2$, $10^x = 0$. The argument x must be stored according to IBM 7094 mode, i.e., the more significant part in an even core location 2n, the less significant part in the odd core location 2n+1.

(D. Hutchinson)

B3-UØI-DLN1-42-SR

Double Precision Natural Logarithm SCATRE, FØRTRAN, MAD. This program computes the double precision natural logarithm of a positive normalized double precision floating point number.

The argument must be larger than zero and must be normalized. If the argument is ≤ 0 an error message will be printed. Some unnormalized arguments will be detected and an error message printed, however, others will lead to errors. Hence, do not enter with an unnormalized argument.

The argument must be stored according to IBM 7094 mode, i.e., the more significant part in an even core location, 2n; the less significant part in odd core location, 2n+1.

(D. Hutchinson)

A1-UØI-FDPØ-43-SR

FØRTRAN and MAD Double Precision Operations. This program enables FØRTRAN and MAD programmers to do double precision add, subtract, multiply, and divide operations by providing a set of subroutines for these tasks. The 7094 double-precision instructions are used to do the arithmetic.

(D. Hutchinson)

M2-UØI-DCNV-44-SR

Convert a Double Precision Floating Point Number to BCD Characters SCATRE, FØRTRAN, MAD. Let the number to be converted by $x = y \cdot 2^p$. The integer n is determined such that

$$.1 \leq x \cdot 10^n < 1$$

then $x \cdot 10^n$ is converted (in fixed point by adding and shifting so that no error is introduced) to 17 BCD decimal digits and the decimal exponent n is assigned.

If $x \geq 1$ then x is divided by 10^{-n} $(n < 0)$ to get $x \cdot 10^n$. If $x < .1$ then x is multiplied by 10^n to get $x \cdot 10^n$ $(n > 0)$. Since the IBM 7094 double precision multiplication as well as the division usually does not yield an exact or even rounded result, some error might be introduced here. Also no attempt is made to round the number before conversion. Therefore for the range $10^{-22} < |x| < 10^{22}$ the last digit could be in error by as much as 2. Outside this range the last digit could be in error by as much as 6. This program will convert any double precision floating point number including unnormalized numbers.

(D. Hutchinson)

D2-UØI-DRK1-45-SR Double Precision Floating Point Runge Kutta SCATRE Only.

This program integrates a set of N simultaneous, first order, differential equations in double-precision floating point arithmetic.

The method of Runge-Kutta-Gill is used.

(D. Hutchinson)

During the month of August, 28 problem specification were submitted for the IBM 7094.

511-37064 Agronomy. Iterative Solution of Horizontal Flow in Finite Columns. A numerical solution of the flow (parabolic partial differential) equation with linear boundary conditions using finite difference methods will be carried out. This leads to a set of linear equations with a tridiagonal matrix:

$$\begin{bmatrix} -B_2 & C_2 & & & & \\ A_3 & B_3 & C_3 & & & \\ & \cdots\cdots & & & & \\ & & A_{N-2} & B_{N-2} & C_{N-2} \\ & & & A_{N-1} & B_{N-1} \end{bmatrix} \begin{bmatrix} \theta_2 \\ \theta_3 \\ \vdots \\ \theta_{N-1} \end{bmatrix} = \begin{bmatrix} -H_2 \\ -H_3 \\ \vdots \\ -H_{N-1} \end{bmatrix}$$

where $\theta_1 = 0$ and $\theta_N = \theta_{N-1}$, θ_i being a dimensionless water content variable, A_i, B_i, C_i and H_i are real numbers depending upon the initial or previously calculated θ's. After each calculation of θ, the current, θC, will be compared to the previously calculated, θP, and if $|\theta C - \theta P| \leq \epsilon$ another time step will be calculated; if not a new estimate of the elements of the tridiagonal matrix will be made and the matrix equation solved again. A specified number of such iterations will be allowed. A typical matrix size is about 100 X 100. The linear system will be solved by an algorithm based upon Gauss' elimination technique.

512-37065 Psychology. A linear Model of Job Satisfaction. This research is aimed at determining the extent to which a worker's job satisfaction is predictable from a linear combination of variables. The major hypothesis to be tested is the extent of the U-shaped relationship between age and job satisfaction as opposed to the linear relationship between the same two variables. Other independent variables such as tenure, salary, job level, and sex are being included as other components of the linear model.

513-37066 Civil Engineering. Construction Project Controls. The object of the study is to develop an information retrieval system for use in controlling the construction of a project. The system must consider separately and collectively all measurements available on construction operations: dollars, man-hours, equipment hours, equipment usage and material usage.

This program will use as its first chain, the Critical Path Method Program (Share). The second chain will develop a correlation table between the operation information available from the CPM Program and the measurement of operations. The third chain will develop information useful for management to measure project status.

514-37067 Dairy Science. Drug Effect on Bulls, 1963. The factors affecting semen production, innervation of the male reproductive tract and the hormones affecting the ejaculatory process are being studied in dairy bulls. This information, obtainable by the use of drugs is of value both in the general field of mammalian reproductive physiology and especially in the narrower area of bovine artificial insemination. With the knowledge obtained from these drugs both an increase in semen production, an increase in the level of fertility and an extension of the useful life of the bull may be available.

515-37068 Economics. Capital Policies-British Post Office. Optimal Tariff and Investment Policies of the British Post Office (Telephone Division) for the next two decades are studied. The policies are analyzed with the aid of a finite horizon dynamic programming. Uncertainties regarding demand for service are incorporated in the model by use of an exogeneously determined state variable. Cost engineering data as well as price elasticity data are used to determine realistic parameters for the model.

516-38001 Electrical Engineering. Analog Simulation. It is necessary to adapt "MIDAS" Program, which was obtained from Wright-Patterson A.F.B. and which was written to be used with Fortran Monitor, to Porthos. "MIDAS" --(Modified Integration Digital Analog Simulator) simulates an Analog Computer and allows programming solutions of sets of differential equations in much the same way in which an Analog Computer is programmed. When the system is debugged it will be used to provide check solutions on Analog Computer problems.

517-38002 Psychology. Cognitive Complexity As a Personality Characteristic. This research problem is a study of several purported measures of cognitive complexity as a personality trait. First, the relationships of the measures to each other will be determined in order to gain some estimate of the validity of the construct cognitive complexity. A later phase of the problem will relate several measures of cognitive complexity to behaviors observed in interpersonal situations.

518-38003 Civil Engineering. Analysis of Vents. This program calculates the pressure in a chamber due to air flow through a vent subjected to an atomic blast. The vent is approximated by an orifice. The computer is used to solve a set of simultaneous equations. Standard library subroutines are used.

519-38004 Institute of Communications Research. Film Hero Study. It is proposed to conduct a cross-cultural comparative study of feature motion pictures and the American "film hero" as a part of an international research project initiated by UNESCO and the American Sociological Association. Invitations have been made by UNESCO and the ISA to conduct the United States field study. Parellel investigations are conducted in selected countries of Europe, Asia, and Latin America.

The field research plan calls for the analysis of feature films and leading characters representing current U.S. production. Methods and instruments designed by social scientists of participating countries will be augmented by techniques developed at the Institute of Communications Research.

In addition to doing the U.S. field study, the investigators will receive comparable data gathered through uniform procedures by all participating research teams, and will analyze and summarize the findings of the international study.

Aside from making an essential contribution to the success of a pioneering world-wide mass media research project, the proposed study presents an opportunity to engage in basic cross-cultural communications research, to apply research experience and methods developed at the Institute for highly relevant purposes, and to provide U.S. participation in the summarization and interpretation of the findings of the international study.

520-38005 Education. Generalized Discriminant Analysis. This is a research problem involving an exploratory survey of an urban school system. A multivariate analysis of 14 variables is required to reduce the data. Generalized variance involving the determinant of the within pooled sum of squares and the total sum of squares is required. For the discriminant function the inverse and eigenvalues of 14 by 14 matrices are required. The 7094 will be used for the computation of eigenvalues, determinants, dispersion, variance-covariance matrices with the associated statistics.

521-38006 Electrical Engineering. Nonlinear Oscillations. The effect of a coil with a "square loop" hysteresis characteristic or the solutions of a van der Pol oscillator are to be studied. A simplified mathematical model is used whose differential-integral equations are readily obtained. Because of the need for a high order of resolution, an analog computer which is usually more suited to the solution differential equations, can not be used. The 7094 will be used to solve this set of differential-integral equations for a number of sets of constants.

522-38007 State Water Survey. Maximum and Minimum Partial Duration Series. This program involves the analysis of stream flow, evaporation and rainfall data. The program will calculate moving averages for various time intervals and then perform a complex sorting process to obtain ranked independent data for determination of frequency distributions. A least squares fit may be used to determine a frequency curve for the ranked independent data determination.

523-38008 Center for Zoonoses Research. Southern Illinois Zoonotic Network. The Center for Zoonoses Research has begun a multidisciplinary study of four counties in southern Illinois. It brings together such disciplines as Human Medicine, Veterinary Medicine, Entomology, Wildlife, Geography, Demography, Climatology, Sociology, Statistics, etc.

The purpose of this study is to discover the factors involved in harboring and transmission of the zoonoses (diseases transmissable from animal to man such as rabies, encephalitis etc.) not only in the human population but in the wildlife population as well and to discover the modes of transmission. It is suspected arthropods may be one of the most important vectors.

Population data of wildlife (insects included) and human habitations are being collected for analysis. Wildlife are being tested for various disease entities. Domesticated animals are not overlooked and in two counties all cattle have been tested for zoonoses of especial interest. Two sociological interview teams are interviewing residents for information on their activity as it relates to disease exposure and blood samples are requested for analysis.

Since a study of this scope has never before been undertaken in this field the methods of analysis are not definitely known at present, but certainly the more powerful statistical methods will be used along with others. Pattern analysis will be very important. The complete analysis of such a study is very dependent upon the 7094 and auxiliary equipment.

524-38009 Psychiatry. Diagnostic Interview Control Study. This study is concerned with twenty-eight brief diagnostic interviews. An attempt is being made to find the relationship between certain variables in the psycho-therapist statements and the same in the patient statements. These variables are the topic of the statement, the affectivity of the statement, the specificity of the statement and newness of the statement. The 7094 will be used for sorting, counting frequencies and for determining correlations. With the information obtained with the 7094 it will be possible to test the relationship between several patient-therapist variables. The use of the 7094 will allow the processing of ten thousand measurements in seven groups of variables.

525-38011 Chemistry and Chemical Engineering. Fused Salt Potentiometry. This research problem is concerned with the electro-chemistry of various ionic species in fused salt media, especially lituhum chloride-potassium chloride eutectic. The 7094 will be used to perform routine calculations, such as least squares fitting, associated with electrochemical measurements.

526-38012 Digital Computer Laboratory. SMP Analysis. This request for a problem specification number is to enable the group working on the SMP to program short problems that will come up as the SMP analysis is carried out.

The first such problems will be concerned with theoretical calculations of the expected number of delta-rays produced by beam contamination.

527-38013 Theoretical and Applied Mechanics. Lexicon for Foreign Language. The program is designed to feed in a series of articles taken from any source in any language. Each article has an identification as to source and any other incidental information desired. Each article consists of whole paragraphs and whole sentences. Each word in the article is given a classification as to its class (noun, verb, etc), tense for verbs (past, present, etc), person for verbs (first singular, etc), and number for nouns (singular or plural).

The program inputs the articles, reproduces the articles on paper output, and then analyzes the articles as follows. If a word is not in an input word list this word is added to the list. If the word is in the list the number of times that word has occured is updated by one. Thus a list of different words and their frequencies is obtained. At the same time the total number of words analyzed to date is updated, the number of sentences and paragraphs to date is saved. From this the

longest and shortest and average sentence and paragraph can be determined. Finally the frequencies of class, tense, person, and number are saved and output. At the end of the run all of this information is saved on punched cards for use in a future run.

The program applies to any language and will be used to obtain a glossary and a grammatical sketch for possible use in developing a dictionary.

528-38014 Psychology. Cognitive Expectancies and Physiological Conditioning. The study was designed to determine the effects of cognitive expectancies (as defined by verbal instructions) on the acquisition, reversal and extinction of physiological conditioned responses. The IBM 7094 will facilitate the several mixed design analyses of variance to be performed on the voluminous physiological data.

529-38015 Physics. Iodine Absorption. This problem involves the analysis of the iodine absorption spectrum. It uses a three point interpolation formula (Hartman's formula) for evaluating the coefficients A, B, C of the equation:

$$\lambda = A + \frac{B}{d + C}$$

where d = distance read from a spectrographic comparator.

The 7094 is used to compute the above coefficients. Those coefficients are then used to compute the wavelength and wavenumber of the particular iodine spectral line.

530-38016 Agricultural Economics. Economic Structure of Capital Markets. Simple and multiple regression will be carried out.

531-38017 Agricultural Economics. Adaptation of LP/90 to Porthos Monitor. Due to the high frequency of use of the LP/90 operating system and to the undesirability of relinquishing the Porthos monitor at this installation, it is felt that some adaptation of the LP-90 system is needed. The outcome of this endeavor will be a comprehensive linear programming package fully operable within the Porthos monitor which at the same time sacrifices as few of the options available in LP/90 as possible. The final program package will, of course, require none of the special operator attention that the LP/90 does at present. By eliminating online input-output and by eliminating the necessity for relinquishing the Porthos monitor, the time necessary for a given problem may be reduced by as much as one-third.

532-38018 Agricultural Engineering. Tractor Controllability. The problem concerns the operational stability (controllability) of conventional and hypothetical tractors on side slopes. In particular the mowing condition will be studied using a mathematical model of a tractor in steady state operation. The solution desired is the tabulation of various operational characteristics of the vehicle as it operates on slopes varying from zero per cent up to a slope steep enough to cause the tractor to become inoperative by all modes. Specifically, the solution calls for forward velocity, steering angle, yawing angle, stability moment, and potential side force--all to be plotted versus the per cent slope to illustrate each condition of operation. These items will be plotted for various values of vehicle and surface parameters.

Usage of the computer facilities will greatly increase the scope of the problem that can be undertaken in the limited amount of time. It is hoped that this method will point out the more critical parameters affecting vehicle stability and thus lead to safer and more stable operations.

533-38019 Political Science. Precinct Committeemen. This dissertation is a study of the role of the precinct committeeman in the Philadelphia area. Involved in the study are a complex set of variables that may be grouped as follows: role potential, the recruitment process, and the intensity of activity. Hopefully, by use of factor analysis, the multitude of variables can be reduced to a few factors that can be related. The data for the study was obtained from questionnaires sent to a sample of committeemen in the Philadelphia metropolitan area.

534-38021 Sociology. Universalism and Team Performance. The aim of this study is to investigate the relationship among the following: a) universalism-particularism b) sociometric choice and c) team performance.

An "inverted" factor analysis will group subjects in terms of their answers to questions relating to universalism-particularism. This grouping of subjects with value similarity is then compared with actual groups in competition in order to test the hypothesis that value similarity is a determinant of the success or cohesion of groups in competition.

An analysis of variance will be used to investigate team performance. The computer is to be used also for a factor analysis.

535-38023 Civil Engineering. Butt Weld Stress Concentration. The problem to be worked out in the machine essentially involves the evaluation of expressions for the elastic stress distribution in a butt welded joint under axial loading for different values of the significant parameters characterizing the weld reinforcement configuration. Included in this evaluation will be the determination of the coefficients of Fourier series used to represent certain functions and the numerical evaluation of the first 20 or 30 terms of such series.

536-38024 Chemistry and Chemical Engineering. Correlation of Bubble Growth Data. As a result of experimental observations, motion picture films of bubbles growing in a supersaturated solution have been obtained. These bubbles appear to be radially symmetric, but are otherwise of a somewhat complicated shape. It is desired to calculate the volume of the bubbles, from the measurements made on the films, and to determine how well the growth corresponds to simple estimates. The calculations involve numerical integration and regression procedures.

537-38025 Civil Engineering. Stress. STRESS - A problem-oriented language and system for structural engineering problems was initially developed by the author at MIT. It enables the user to specify in his own engineering terminology, the problem to be solved. The system interprets the user's commands, checks them for consistency, and "compiles" a program by assigning storage to the data arrays and setting up transfers to the subroutines to be used. The resulting program is then executed, using a network formulation of structural analysis.

Initially, it is intended to recompile the original MIT system and make it available for classroom use. Later, it is intended to expand the system to allow more efficient use of the machine, larger problems, and more comprehensive problems to be solved.

538-38026 Mechanical Engineering. Steam and Condensate. The IBM 7094 will be used for computational work associated with this two-phase flow study. In particular, it will be used to establish dimensionless parameters, flow areas, and flow velocities. Later the data may be subjected to a statistical analysis.

During the month of August, 3 instructional problems were submitted for the IBM 7094.

171-38020 Electrical Engineering 343. Problem 1. Class Preparation. The computer will be used to prepare problems for Electrical Engineering 343. Matrix and complex algebra subroutines will be used.

172-38027 Mathematics 195. Scat Demonstration Problem. A demonstration problem illustrating program format, printouts, etc. Students are given a card deck to which an I.D. card only is to be added.

173-38028 Mathematics 195. Scat Handout. A sample deck is to be handed out to the Mathematics 195 classes in order to demonstrate program format and identification card procedure. Students will receive a complete program deck except for the ID card which they will furnish themselves.

Information on the utilization and reliability of the IBM 1401 and IBM 7094 for the month of August, 1963 is given in the tables below.

TABLE I - IBM 1401
Summary of Use
August, 1963

Scheduled Engineering	-0-
Unscheduled Engineering	15:52
Maintenance	4:53
7094 Preparation	451:52
Listing	15:48
Tape Dump	10:14
Code Checks	13:25
Scanning Measuring Projector	25:16
Reproduction	1:28
Tape Test	26:12
Tape Copy	:15
Idle	15:05
	580:20

TABLE II - IBM 1401
Summary of Machine Errors
August, 1963

1401 Main Frame and Storage	1
1402 Read-Punch	7
1403 Printer	8
729 V Tape Units	8
	24

DATE	RUNNING OK TIME	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURE	IBM 1401 DAILY TIME DISTRIBUTION
8/1/63	24:00				24:00		
8/2/63	23:30			:30	24:00		
8/3/63	15:05			:45	15:50		
8/4/63	:55				:55		
8/5/63	15:50		:15		16:05		
8/6/63	24:00				24:00	1	(1) Reader having trouble reading cards correctly. Engineered on 8/7/63
8/7/63	20:30	3:30			24:00	4	(1) Reader will not work. Start-reset switch replaced by engineers. (2) Fan was repaired on 1401. (3) Ribbon drive on 1403 printer stops forward motion intermittently. (4) Tape unit B does not come out of high speed rewind correctly.
8/8/63	24:00				24:00	1	(1) Tape unit B taken off-line to replace high-speed rewind motor.
8/9/63	22:30	1:30			24:00	2	(1) Carriage runaway on 1403 printer. Engineer replaced ribbon drive motor and also did preventive maintenance on 1403 carriage. (2) Tape unit B does not read tape properly. Bad interlock found.
8/10/63	14:10		:15		14:25	1	(1) Tape unit B still in error.
8/12/63	15:45				15:45		
8/13/63	21:50	2:10			24:00	3	(1) Reader will not feed cards. Loose nut found on end of read clutch. (2) Ready light on unit B has loose connection. (3) Reader rejecting good cards.
8/14/63	19:45	4:15			24:00	3	(1) 1403 printer skips pages. (2) Ready light and low density light are out on tape unit B. Replaced. (3) Engineers replaced brushes, retimed 1402 reader and replaced blown fuse on Tape unit A.
8/15/63	23:12		:10	:38	24:00		
8/16/63	20:08	2:37	:15	1:00	24:00	2	(1) Could not remove the 1403 forms check. Found that upper right interlock and forms tractor were out of adjustment. Adjusted by engineers. (2) Put new set of brushes in secondary reader and timed them.
8/17/63	12:00				12:00		

TABLE III (CONTINUED)

DATE	RUNNING OK TIME	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURE	IBM 1401 DAILY TIME DISTRIBUTION
8/18/63	6:00				6:00	1	(1) Fuse blown on tape unit A. Was replaced by engineers.
8/19/63	16:25		:25		16:50		
8/20/63	23:05			:55	24:00	1	(1) 1402 Reader rejecting good cards. Reason not found.
8/21/63	21:40	1:15		1:05	24:00	2	(1) 1403 giving trouble ejecting paper. Paper guides were found to be giving the trouble and were taken off. (2) Fuse blown on tape unit A. Trouble went away after unit was reset.
8/22/63	23:38		:15	:07	24:00		
8/23/63	20:07		2:18	1:35	24:00		
8/24/63	11:30				11:30		
8/25/63	11:20				11:20		
8/26/63	15:40			:20	16:00		
8/27/63	21:37	:35	:15	1:33	24:00	1	(1) 1403 ribbon stops forward motion intermittently. Engineer cleaned clutch and trouble disappeared.
8/28/63	22:17		:15	1:28	24:00	1	(1) 1403 ribbon stops forward motion intermittently. Trouble not found.
8/29/63	21:31		:30	1:59	24:00	1	(1) 1403 printer carriage ran away. Trouble not found.
8/30/63	21:50			2:10	24:00		
8/31/63	10:40			1:00	11:40		
	544:30	15:52	4:53	15:05	580:20	24	

TABLE I - IBM 7094

Summary of Use

August, 1963

Scheduled Engineering	30:19
Unscheduled Engineering	9:56
Air Conditioning	:40
Production	610:21
System Updating	2:51
Operator Manipulations	89:53
	744:00

TABLE II - IBM 7094

Summary of Machine Errors

August, 1963

7094	7
7631 Disk File Control Unit	3
729 VI Tape Units	9
Cathode Ray Tube	4
Multiplexor	4
711 Reader	2
	29

TABLE III

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANIPU-LATION	TOTAL RUNNING TIME	FAILURE	IBM 7094 DAILY TIME DISTRIBUTION
8/1/63	17:57				6:03	24:00		
8/2/63	17:27	1:25	1:28	:40	3:00	24:00	2	(1) Tape unit V will not write tape and was taken off-line. (2) Power check on multi-plexor caused by air condi-tioning but trouble not found.
8/3/63	20:47		:55		2:18	24:00	3	(1) Power check on 7109 due to overheating. (2) Power check on 7109 due to overheating. (3) Fuse blown on 7631 and replaced.
8/4/63	24:00					24:00		
8/5/63	20:02	:55			3:03	24:00	1	(1) C.R.T. taken off-line because of burned out coil which was replaced.
8/6/63	16:18	1:25			6:17	24:00	1	(1) C.R.T. still not func-tioning properly. Bad coil suspected and was taken off-line.
8/7/63	17:41	1:20	:10		4:49	24:00	4	(1) Left capstan sticking on tape unit U. (2) Right capstan sticking on tape unit U. (3) Tape unit U has trouble reading but checked out O.K. (4) Power checks on 7109 due to overheating.
8/8/63	19:43	:30			3:47	24:00	1	(1) 711 reader not reading cards correctly.
8/9/63	15:49	:25	2:34		5:12	24:00	3	(1) Machine failed to do diagnostic test correctly. Trouble seemed to be in the indirectly addressed float-ing point instruction, but went away before found. (2) Engineers checking out problem on disk file. (3) 711 reader not reading cards correctly.
8/10/63	21:08		:25		2:27	24:00	1	(1)Machine failure on diag-nostic test but went away.
8/11/63	24:00					24:00		
8/12/63	18:46	1:15			3:59	24:00		

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANIPU-LATION	TOTAL RUNNING TIME	FAILURE	IBM 7094 DAILY TIME DISTRIBUTION
8/13/63	17:45	1:15			5:00	24:00	1	(1) Error on diagnostic routine but went away.
8/14/63	17:57	1:02	1:20		3:41	24:00	2	(1) Error in diagnostic routine, but disappeared. Suspect that monitor version of diagnostic routine altered from IBM version. (2) Disk went off line for engineering change.
8/15/63	20:00	1:06			2:54	24:00	1	(1) 7094 inserted the message, "end of input batch" in middle of input tape.
8/16/63	18:40	:30			4:50	24:00		
8/17/63	22:25				1:35	24:00		
8/18/63	24:00					24:00	1	(1) Tape unit X gave machine error on reading while using 3 different tapes. Engineers adjusted tape unit X.
8/19/63	20:35	1:16			2:09	24:00		
8/20/63	17:04	2:00	2:44		2:12	24:00	2	(1) C.R.T. recorder does not function properly. Hangs up after taking 200 or so frames sequentially when it is capable of taking 660 frames sequentially. (2) Machine will not execute an ORA instruction properly. Trouble not found.
8/21/63	17:44	1:30			4:46	24:00		
8/22/63	19:46	2:20			1:54	24:00	1	(1) Tape unit R giving intermittent R/W errors. Trouble not found.
8/23/63	18:33	2:15			3:12	24:00	1	(1) Tape unit R fouled tape on drive capstan. Engineers adjusted flapper valve switch and cleaned capstan.
8/24/63	22:34				1:26	24:00		
8/25/63	24:00					24:00		
8/26/63	19:04	2:00	:20		2:36	24:00	1	(1) 7094 will not read in master Tape I. Trouble disappeared before it could be located.
8/27/63	19:53	1:55			2:12	24:00		

TABLE III (CONTINUED)

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANIPU-LATION	TOTAL RUNNING TIME	FAILURE	IBM 7094 DAILY TIME DISTRIBUTION
8/28/63	18:44	2:00			3:16	24:00	1	(1) Tape unit W taken off-line for repair of prolay.
8/29/63	19:21	2:00			2:39	24:00	1	Tape unit W placed back on-line with prolay repaired. (1) C.R.T. overloads and hangs-up. Trouble not found.
8/30/63	19:09	1:55			2:56	24:00	1	(1) C.R.T. has bad tube and was taken off-line.
8/31/63	22:20				1:40	24:00		
	613:12	30:19	9:56	:40	89:53	744:00	29	

DEPARTMENT	Number of Runs: Classes	Number of Runs: Research	Number of Runs: Non System	Number of Runs: Total No. of Runs	No. of Problem Specifications: Classes	No. of Problem Specifications: Research	No. of Problem Specifications: Non System	No. of Problem Specifications: Total No. of Prob. Specs.	Total Time Used: Classes	Total Time Used: Research	Total Time Used: Non System	Total Time Used: Total Time Used
Aeronautical and Astronautical Engineering		148		148		3		3		2:05		2:05
Agricultural Engineering		106		106		4		4		2:19		2:19
Agricultural Economics		92	13	105		6	2	8		7:59	13:18	21:17
Agronomy		162		162		14		14		1:48		1:48
Animal Science		34		34		5		5		1:07		1:07
Anthropology		6		6		1		1		:25		:25
Architecture		35		35		1		1		:20		:20
Bureau of Economic and Business Research		18		18		2		2		:25		:25
Civil Engineering	628	1676		2304	4	38		42	7:03	53:33		60:36
Chemistry and Chemical Engineering	1	1166		1167	1	36		37	:01	54:02		54:03
Communications		79		79		2		2		:41		:41
Digital Computer Laboratory	13	679	72	764	1	17	4	22	:08	10:31	315:25	326:04
Dairy Science		31		31		2		2		:51		:51
Economics		6		6		1		1		:26		:26
Education		60		60		8		8		1:45		1:45
Electrical Engineering	17	503		520	1	13		14	:16	7:17		7:33
Forestry		46		46		2		2		1:24		1:24
Food Technology		14		14		2		2		:08		:08
General Engineering		4		4		1		1		:05		:05
Graduate School, Business Administration		6		6		1		1		:03		:03
Horticulture		1		1		1		1		:01		:01
Institute of Communications Research		24		24		3		3		1:39		1:39
Industrial Education		2		2		1		1		:01		:01
Institute of Government and and Public Affairs		5		5		1		1		:18		:18
Instructional TV		32		32		2		2		1:18		1:18
Institute for Research on Exceptional Children		12		12		2		2		:48		:48
Law		12		12		1		1		:29		:29
Mathematics	1212	22		1234	1	2		3	15:33	:09		15:42

TABLE IV - (CONTINUED)

DEPARTMENT	Number of Runs				No. of Problem Specifications				Total Time Used			
	Classes	Research	Non System	Total No. of Runs	Classes	Research	Non System	Total No. of Prob. Specs.	Classes	Research	Non System	Total Time Used
Mechanical Engineering		295		295		13		13		8:23		8:23
Mining, Metallurgy and Petroleum Engineering		60		60		2		2		:20		:20
Men's Residence Hall Association Rocket Club		38		38		1		1		:31		:31
Natural History Survey		4		4		1		1		:27		:27
Nuclear Engineering		133		133		2		2		4:48		4:48
Office of Instructional Research		135		135		1		1		3:41		3:41
Physics		1032		1032		20		20		28:59		28:59
Psychology		566		566		26		26		35:15		35:15
Psychiatry		4		4		1		1		:02		:02
Sociology		15		15		1		1		:10		:10
Statistical Services Unit		484	2	486		1	1	2		8:30	:52	9:22
State Water Survey		282	1	283		8	1	9		7:12	:20	7:32
Theoretical and Applied Mechanics		258	2	260		7	1	8		5:35	:39	6:14
Zoology		3		3		1		1		:10		:10
Sub Total	1871	8290	90	10251	8	257	9	274	23:01	256:00	330:34	609:35
Instruction		55		55		1		1		:46		:46
Grand Total	1871	8345	90	10306	8	258	9	275	23:01	256:46	330:34	610:21

PART VI
GENERAL LABORATORY INFORMATION

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	16	0	16.0
Visiting Faculty	2	2.0	3.0
Research Associates	1	1.5	2.5
Graduate Research Assistants	4	33.0	14.45
Graduate Teaching Assistants	0	.25	.25
Professional Personnel	3	0	3.0
Administrative and Clerical	7	0	7.0
Other Nonacademic Personnel	49	43.0	79.5
TOTAL	82	79.75	125.7

The Computer Advisory Committee consists of Professors H. C. Brearley, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During August a total of 101 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	4	2
Medium Drawings	1	7
Small Drawings	1	0
Reports	48	0
Change Orders	32	0
Printed Circuits	0	0
Miscellaneous	6	0
TOTAL	92	9

In addition, many multilith drawings were made for Pattern Recognition report purposes and drawings were made for slide presentation at ACM conference.

(K. Law, P. Richardson)

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM

PART II - ILLIAC II SYSTEM PROGRAMMING AND OPERATION

PART III - CIRCUIT RESEARCH PROGRAM

PART IV - IBM 7094-1401 SYSTEM

PART V - GENERAL LABORATORY INFORMATION

SEPTEMBER 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction

In terms of transistor counts the following progress has been made during September.

Chassis D C checked	342
Chassis inspected	542
Chassis in wiring	306
Printed circuits (197 cards) wired	1233
Printed circuits (7 cards) modified	32
Printed circuits (8 cards) repaired	9

(F. Seric, T. E. Kerkering)

2. Component Testing

a. Life Tests

More effort is being placed on the evaluation of long term behavior of semiconductor diodes, particularly those of unproven reliability offered by various low bidders. At the present rate at which diodes are wired (several thousand per month) it seems unwise to blindly use those which the low bidder system forces us to buy, without several thousand hours of sample evaluation. Accordingly, 75 diode samples have been placed on test at 10 ma forward conduction. A larger, more elaborate tester is also being built.

Though our practice up till now has been to life test transistors by placing them in sockets in repetitive Arithmetic Unit Chassis, this may have to cease. Recently, after many man-hours of effort spent in tracing intermittent faults, it was found that two units purchased from one particular low bidder were quite unstable in their voltage breakdown properties. These failures from a total sample of 100 units were in

addition to 3 more outright failures during the 11,000 hours of test.

It is fortunate in retrospect that incoming tests of these units showed them to be inferior to our regular brands in the sense that though they met all of the registered specifications, they did so considerably less well. Fortunately, soon after the initial evaluation, our regular supplier reregistered his product so that we were able to respecify another type and avoid the previous low bidder, who was unable to meet the improved specifications cheaply. Hence, only 100 samples of these units were ever installed.

This experience supports the view that blind acceptance of low bids without any consideration of the supplier's reputation and past performance is totally inconsistent with the maintenance of multimillion dollar systems, where a failure of any one of hundreds of thousands of parts means total failure.

b. Acceptance Tests

Routine 100% inspection was done on 2600 transistors and 7100 diodes of assorted types including 3500 TI 51. In addition, 750 transistors were pedigreed prior to testing in the machine.

(B. Doden, K. C. Smith)

3. Component Failures

A summary of component failures during the 5 month period, May 7, 1963, to September 30, 1963, has been prepared.* Approximately 110 components failed in 3000 hours of operation, 76 of these caused machine stoppage. Some of the failures were associated with newly operating equipment and represent the usual initial difficulties.

(C. E. Carter)

* To be issued also as File No. 571.

A survey of signals present at the collectors of all inverters on the main frame has been made.* In addition to various probe-sensitive locations, 10 open collector diodes were found bringing the total of these in the past year to 21. Though no test other than machine operation is available to check logic diodes, this much larger population has shown almost no failures. It is apparent that bump failures should be investigated further to establish the cause of this anomaly.

(C. E. Carter, L. Byers)

4. Power System Check

A dc voltage margin was carried out on rear bays 5, 6, 7, 8, 9, 10, 13, 14, 16 and front bays 5, 6, 8, 9, 10, 13, 14, 15, 16 of the main frame using a single voltage change of ± 10% on +25v and -50v. The program used during the marginal test was DAMN. All bays passed the test with the exception of the following:

Bay	Voltage	Failure Point	Test Failure
5R	-50	at -45 v	KgA, 87
5R	+25	at +27 v	SUB1
7R	+25	at +27.5 v	ADD, SUB
7R	+25	at +22.5 v	ADD, SUB
6F	+25	at +27 v	MPY, ADD
8F	+25	at +27 v	ADD

(C. E. Carter, L. L. Byers)

* To be issued also as File No. 570.

5. Magnetic Drum Memory

The seven read-write chassis were updated to be identical. The peak detector dead-band was widened to avoid false detection of base line ripples. The read amplifier maximum output level was increased to avoid clipping at high gain settings.

The conversion of drum 128 from fixed to flying heads mentioned in the August, 1963 report is proceeding. After drum 128 is received from the manufacturer and the associated changes are made in the electronics, we plan to have drum 129 converted to flying heads also.

All heads on drum 129 were examined for output voltage at high and low density, for resolution and for pulse crowding. The 16 heads connected to each bit were compared, and some heads were readjusted to improve the uniformity. Considerable time was spent examining the electronics, and running test programs.

A formal description of test program Pl-DTC-52v, which writes and reads fixed data patterns on all drum blocks, was published. Work began on a write-read-wait test program and a band-switching program.

(H. C. Brearley, M. D. Freedman,
R. L. Miller, G. E. Cooper,
R. A. Marlett)

6. Interplay

Plans for a buffer distributor to improve the fanout of generally distributed signals have begun.

Two chassis of type CC4, etc., have been dc checked. The remaining 5 chassis of Interplay necessary for 32 channel operation are in various stages of preparation.

(S. P. Krabbe)

7. <u>New Console</u>

Rack mounting and cabling are in process for final installation of the console. Work on the indicator panel has resumed.

(H. Lopeman, T. Kerkering,
R. Kingsley)

8. <u>IBM 1301 - Interplay Channel</u>

A method of handling block transfers for the IBM 1301 Channel has been devised. Facility has been provided for programmably setting records to a read-only status. It is occasionally necessary to write continuous records of greater than 256 words; two methods of accomplishing this have been proposed and are being studied.

(G. Yen, R. E. Willard)

9. <u>Engineering Test Console, PAU - Interplay Channel</u>

Dynamic checking of Interplay Channel 16 with ILLIAC II has begun. Driver boards for communication with the Test Console are as yet incomplete.

(G. Krabbe, G. Yen)

10. <u>IBM 1414 Interplay Channel</u>

Wiring of Interplay Channel 3 is nearing completion. Completion of wiring by mid-October is expected.

(H. Lopeman, M. J. Pisterzi, R. Willard)

11. <u>Remote Console Connection</u>

The IBM Selectric for use on the console has arrived and preliminaries to logic design for its connection have begun.

Two IBM 1050 stations have been ordered as a basis for the remote console investigation. The simpler of the two units which will be used as an ILLIAC II terminal connection may be delivered by the new year.

(H. T. Hsu, G. Metze, D. Tabak)

PART II

ILLIAC II SYSTEM PROGRAMMING AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Fortran Compiler

A start has been made on a fast Fortran compiler for ILLIAC II. This effort involves Fosdick, Hamilton, Foster, Gear and some assistants.

2. System

A provisional system program to enable batched running of cards in NICAP without the memory protect feature is being written. This will include some elementary dump in octal. A program to convert the paper tape system version of NICAP to cards has been written.

(C. W. Gear)

3. Library

Final changes are being made to the Inverse Laplace routine to meet library conventions in preparation for conversion to NICAP.

(E. Brower)

A Gauss Quadrature subroutine has been written and checked out. It is now being converted from System II to NICAP.

Constants needed for an exponential subroutine have been generated.

(Lorinne Lunde)

The subroutine "Complex Roots of a Polynomial" was converted from System II to NICAP. Routines to check it are being generated.

(T. A. Slivinski)

The Lagrange Interpolation routines are being checked out in NICAP.

(C. W. Gear)

The Runge-Kutta routine for the solution of a system of ordinary differential equations has been rewritten for the NICAP library.

(F. Schaffer)

Work has begun on the Householder method for reduction of a real symmetric matrix to a codiagonal form.

(J. Presti)

4. Input/Output

Checkout of the decimal print and read routines is continuing.

(M. Gaer)

The trace routine is still being checked out.

(F. Schaffer)

5. Interrupt

The Interrupt programs for illegal memory use, undefined orders, the halt order, and protected orders are written. Also completed is a subroutine called "interrogate." It will be to the programmer's advantage to use this subroutine if any reference is made in his program to a block which was previously involved in a transfer to or from core memory.

Work will now be directed toward tests to check out the various Interrupt programs. Final code checking cannot occur until auxiliary storage equipment is connected and in working order, and the second core memory is installed.

(J. Aaron)

6. ILLIAC I Simulator

Further work was done on the ILLIAC I Simulator with the result that 248 of the possible 256 order combinations are now accounted for but not code checked. Output subroutines with the 1401 were code checked and routines are now running utilizing the magnetic drum.

Brief specifications of the program are:

1. Input via converted paper tape.
2. All output via the 1403 printer.
3. No CRT.
4. Console operation same as ILLIAC I.
5. Order code simulation to match that of the 1604 SIMILE program written at the Coordinated Sciences Laboratory.
6. Magnetic drum simulated on magnetic drum.

The locked-out portion of the ILLIAC I drum has been reproduced on ILLIAC II's magnetic drum successfully. First run testing of the program will be done by running the old test routines formerly used with ILLIAC I.

(J. Bouknight)

7. Operations

a. Log

Engineering Test Routines

ETR	4:40	
Duplex Memory	:40	
Memory Reversing	:01	
Cross Talk	1:20	
DAMN	266:11	
Store Test	1:30	
B.T.C.	6:05	280:27
Engineering		
Interrupt Engineering	1:05	
Drum Engineering	42:24	
General Engineering	172:47	
Console Engineering	7:43	223:59
Code Checking		83:49
Production		
Jordan	2:45	
Nievergelt	31:00	
Math 001	5:52	39:37
Demonstrations		
		2:42
*Idle		68:30
*Power Off		20:56
Total Hours Running		720:00

(W. L. Huffman)

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* These two items occurred in the main after midnight when no one was present.

b. *Component Failures**

1. Transistors		
Spontaneous	17	
Induced by other failure	4	
Out of Spec.	6	27
2. Diodes		
Spontaneous	2	2
3. Capacitors		
Spontaneous	6	6
4. Resistors		
Spontaneous	3	3
5. Fuses		
Spontaneous	1	1
Total Component Failures		39

c. *Computer Errors

Reader Parity	5
Core Parity	3
Arithmetic	1
Power Dumps	6
Unknown	1
Total Errors	16

(W. L. Huffman)

* These two sections refer to Main Frame, Core Memory, and Input Output System.

** See File No 571 , Logged Component Failures, C. E. Carter

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Sergio Ribeiro and Gabor Ujhelyi have started on a project involving photocoupled tunnel-diode circuits. The advantages of such a coupling system are that directivity is obtained by the respective irreversibility of lasers and photodiodes. The reflection problem can be minimized by appropriate design of the photodiode housing. There are, right now, great difficulties having to do with the low temperature environment needed by junction lasers to attain reasonable efficiencies, but the advent of room temperature lasers will obviate these. The system seems capable of nanosecond rise times.

Henry Guckel has encountered difficulties with the epoxy solder for his microwave structure. Possible new approaches are being looked into. He has also studied Goto pairs with varying bias.

Louis van Biljon has continued his investigation of microplasms in transistors nearing the avalanche mode. It is hoped that practical circuit application will be possible in the near future.

2. Photocoupled Circuits

The aim of this new project is to investigate the possibility of using a laser-diode and a photo-diode to effect the coupling of tunnel diode circuits. In the basic digital cell the input signal is a light beam incident upon the photo diode, which converts it into the electric input of a tunnel diode current amplifier. The output of this amplifier is converted back to a light beam by a laser diode. Such a tunnel-diode current amplifier may have positive and/or negative gain (see Figs. 1 and 2), and if several signals are simultaneously fed into the photodiode, logical functions can be performed. With the TD amplifier operating in the switching mode, it is possible to obtain the AND and OR functions, according to the threshold setting. Other logical functions may be obtained by using two symmetrically biased photo-diodes. The logical NOT of the output is always available from the other lasar diode. A memory element (as a flipflop) can be realized with a single

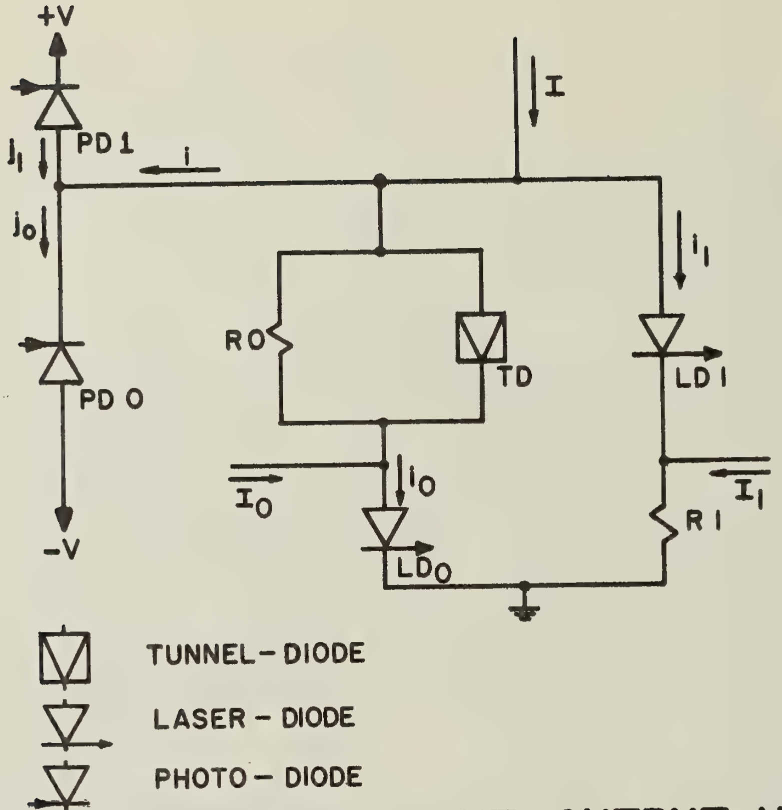


FIG. 1: SYMMETRIC-INPUT-OUTPUT UNIVERSAL CIRCUIT.

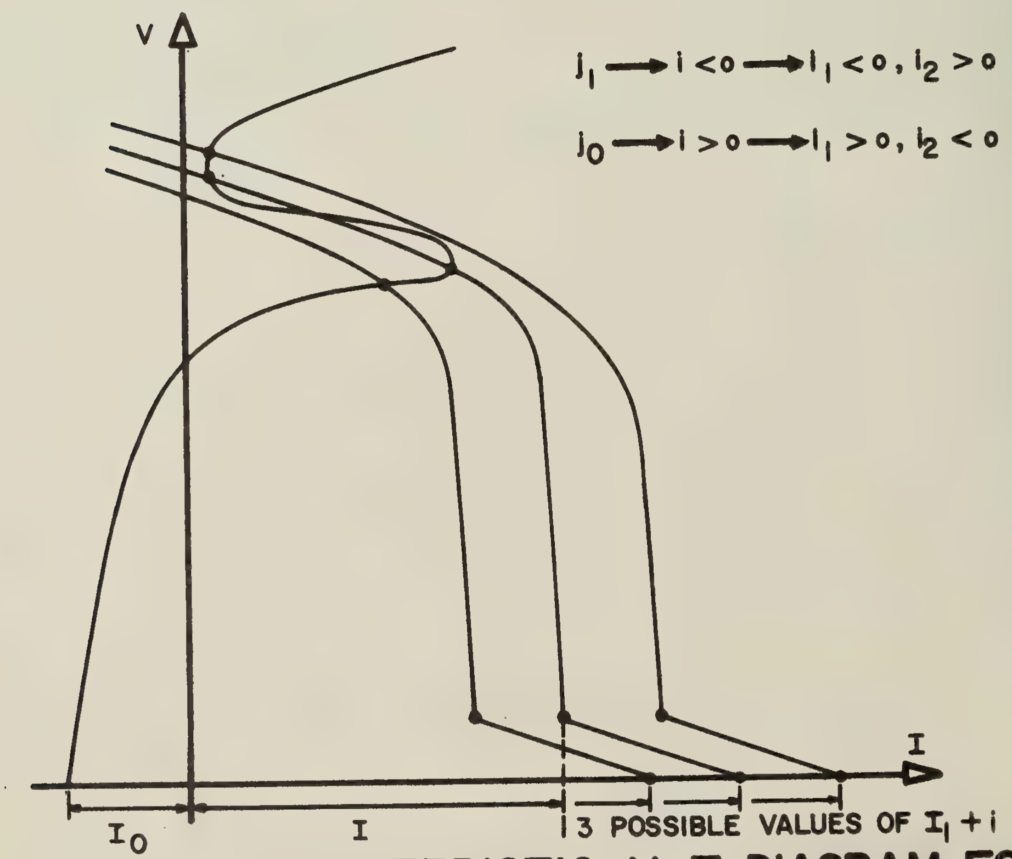


FIG. 2: CHARACTERISTIC V-I DIAGRAM FOR THE CIRCUIT OF FIG. 1

cell by proper biasing----or internal light feedback - again using two opposing photo-diodes (the set-to-0 and set-to-1 inputs respectively). Fig. 1 shows a proposed topology which, by proper adjustment of biasing currents, could be made to perform any of several logical functions, as shown in the diagrams of Fig. 2.

The main advantages of such a photocoupled system are:

1. The inherent speed of tunnel diodes, laser diodes and photo diodes allows the design of circuits working at about 1Gc/sec. The long-range goal of 10 Gc/sec does not seem to be excessively optimistic.

2. The three types of device seem to be quite compatible from a circuit point of view. The ranges of voltages and currents, as well as static V-I characteristics, dynamic impedances, frequency responses and parasitic elements, all seem to cause no unusually difficult circuit or impedance matching problems.

3. The versatility of circuit design is a convenient feature, especially the possibility of constructing cells whose logical functions can be modified by the biasing conditions (such as that of Fig. 1).

4. The directivity of signal flow is assured by the irreversible nature of the quantum-electronics phenomena involved in the operation of laser and photo diodes.

5. The fact that, theoretically, any logical function can be realized by a single cell with a universal topology, including memory functions, is a practical advantage.

6. Besides the gain provided by the cell itself, the use of two or more laser junctions in series (a theoretically possible multi-junction-laser) can provide some gain -- or at least reduce the losses -- in the optical coupling. It is clear that coherence is only needed insofar as high quantum efficiency is concerned; if incoherent light beams can be produced with high efficiency, there will be no need for laser diodes properly, but just for light-emitting diodes.

7. As a bonus advantage, if the laser diodes are chosen to operate in the visible part of the spectrum, the maintenance of the system would be simplified, since, at no extra cost, we would virtually have one indicator lamp in each output branche, for every logic cell in a system.

There are, however, several difficulties to be overcome before any practical circuit emerges. Unfortunately, they lie on the side of devices:

1. Although the theoretical limit of laser-diode quantum efficiency is near 1, the practical limit outside the crystal is probably about 3/4. Photo diodes may have a high quantum efficiency (maximum nearly 1 at a center wave length). Assumming a well conceived geometry, a coupling transfer ratio of more than 1/2 is certainly possible. Multiple-junction-lasers could be used to yield a coupling transfer ratio higher than 1. In this case, the tunnel diode amplifier could be eliminated.

2. At the present state of the art, there are no commercially available photo diodes with the high efficiency and the large area required. Also, junction-lasers with low threshold currents seem to be very difficult to construct, and such thresholds are usually in the order of amperes. The reported efficiencies are anywhere between 5% and 50%. We need reliable junctions, with more than 30% efficiency and thresholds of a few miliamperes.

3. A practical difficulty is the fact that the available junction-lasers work at very low temperatures at which the other devices (mostly due to inadequate encasing) do not operate properly.

4. There have been experimental laser diodes working at room temperatures; the range of operation of laser diodes has been extended to the visible part of the spectrum; for some conditions efficiencies of 60% have been measured. There is no basic reason opposing the joint occurrence of these three events. Experimental photo diodes have been constructed with almost unit maximum quantum efficiency, capable of above 1 ma output currents and with designed output frequency cutoff above 18 Gc/sec. (measured only up to 2 Gc/sec. due to instrumental limitations.)

In the way of realization of these devices, the individual characteristics of some components were measured and from this data some preliminary circuit designs were completed. During the tests it was found that the SD 100 photo diodes and some of the tunnel diodes fail at 77°K. (Apparently the seals and/or the ohmic contacts are damaged by strains.) A special Dewar bottle (with transparent walls) will be used for further experiments; this way only the laser diode will be cooled. It was disappointing to find that the extremely fast (5 KMC) Philco L4501 photo diode has a very small effective area and therefore it is not suitable for our purposes (its output current is too small.)

The following circuit looks promising:

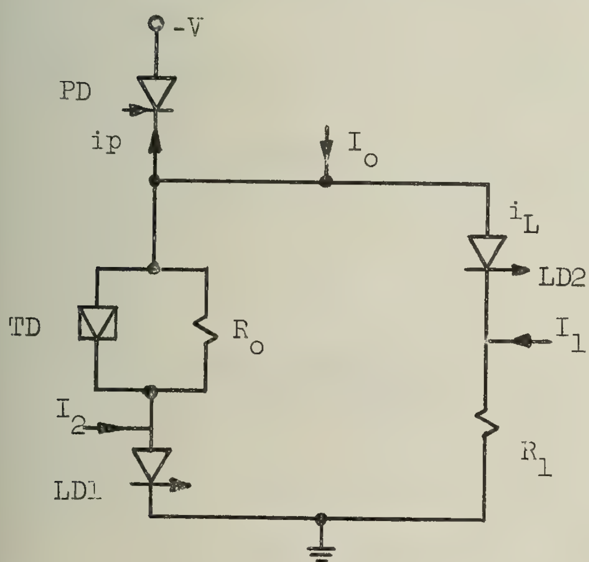


Figure 3. Practical Photocoupled cell.

$$\left.\begin{aligned} I_o &= 28 \text{ ma} \\ I_1 &= 55 \text{ ma} \\ I_2 &= 6 \text{ ma} \end{aligned}\right\} \text{ bias currents}$$

LD1, LD2 are laser diodes

TD is a 20 ma Ge tunnel diode

The calculated gain is approximately

$$G = \frac{\Delta i_L}{\Delta i_p} = -5$$

3. Tunnel Diode Work

Attempts have been made to evaluate the previously designed Goto-pair layouts. Results indicate that

a. The lay-out is satisfactory for the 1ma Microstate germanium diode (MS 1049.)

b. Unsatisfactory results occur for the 5 ma Ga As diode (MS 1550.) This resulted in a re-design of the boards and measurement jigs.

Tests on several circuits, which were assembled during the summer yielded the conclusion that the epoxy solder cement now in use is unsatisfactory. Contact resistance increases were found to be large. Since some circuits employ resistors as low as 2 ohms, and increases affect these circuits adversely if more than 20 milliohms are added, the measured increases of up to 1.8 ohms must be considered detrimental. The inability to use epoxy cement has serious consequences. Bias resistors cannot be soldered, and the soldering of the pill package diode results in a nearly permanent assembly, i.e., if the assembly fails, the diode is lost. No complete answer to this problem has been found.

Attempted studies of the relationship between the Goto pair bias and the v-i characteristic of the Goto pair resulted in the following conclusions:

1. A high bias gives a large linear resistance range compared to a low bias.
2. A high bias yields a larger value of negative resistance than a lower one.

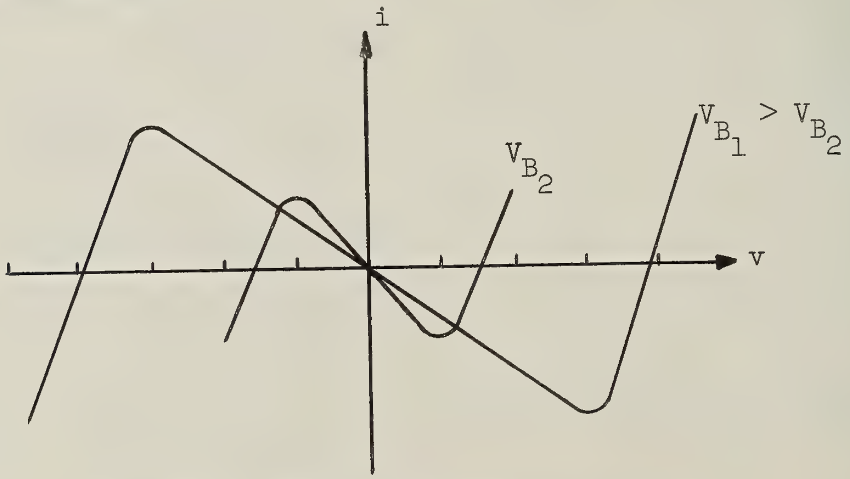


Figure 7. Goto Pair Characteristics

This seems to resolve the difficulty of obtaining varying voltage gains from the amplifiers (proportional to the linear region.) Up to this point this has been accomplished by using Ga As units. It is felt that this is no longer necessary, thus eliminating the cost involved as well as the speed decrease of the Ga As units.

4. Avalanche Circuits

Detailed study of the base-collector breakdown behavior has shown that very small breakdowns, probably single microplasmas, can be observed in junction transistors.

The reason for believing the observed breakdowns to be single breakdowns is the following:

When the base-collector voltage is raised until the first current spike is observed, further slight increase in voltage does not increase spike amplitude but merely stretches it in time. However, a further slight increase in applied voltage causes a jump in current to a new higher level where again increase in voltage causes pulse stretching--Fig. 5 (a) and (b). This behavior is similar to microplasma behavior observed by other workers with diodes.

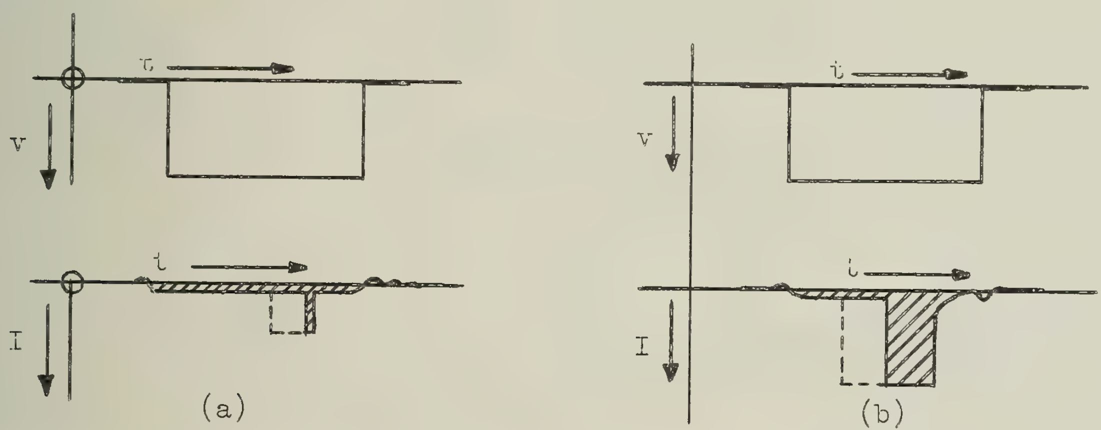


Figure 5. Pulse Stretching in Microplasms

The current levels and pulse durations observed here, although probably associated with a single breakdown, are believed to be far bigger than may profitably be employed in practice. However, smaller breakdowns are not observable as only at relatively large current levels (200 → 300 μa) does the breakdown tend to become periodic and thus can be displayed on a normal scope.

No transistors have been found where a periodic small breakdown could be induced by pulsing the applied voltage.

Inducement of microplasma formation has been attempted by light pulses; no success with incandescent sources was obtained but a laser pulse without fail caused a large breakdown, probably involving the whole junction. Considerable refinement in apparatus will be required before this part of the experimental investigation can be adequately performed.

The theoretical field   current relationship within a junction is being considered, particularly in the presence of a small discharge. Considering work by Rose and Shockley, it was decided that the electrical equivalent circuit and also the field distribution within a junction displaying a small breakdown would probably be as in Fig. 6.

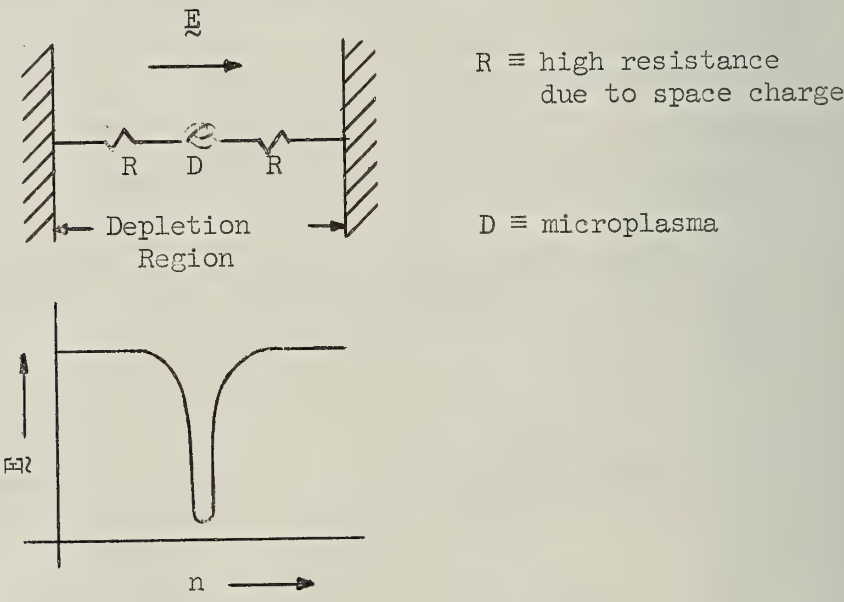


Figure 6.

This simple model may aid the analysis of current transfer across the junction under high field strength conditions. If the dimensions of D are small enough the propagation of the excess charge concentration originating at D and being acted on by the field may be similar to a heat flow problem--this is being considered at present. The important problem is that of effective mobility while the charges are in transit across the junction.

Considering the average energy gain per collision between a charge and the lattice, the average rate of energy gain for all particles will be found as follows:

Average energy gain/particle/collision = $d\epsilon$

Collisons/unit time = $\dfrac{\text{velocity}}{\text{mean free path}} = \dfrac{v}{\lambda}$

$\therefore$ Mean rate of energy gain/particle = $\dfrac{v}{\lambda}\, d\epsilon$

Assuming a velocity distribution such that N(v) dv particles are present in the velocity range dv, the average rate of energy gain for all charges crossing the junction will be

$$\left.\frac{d\epsilon}{dt}\right|_{\substack{\text{all}\\ \text{particles}}} = \frac{\displaystyle\int_0^\infty \left(\frac{N(v)d\epsilon}{\lambda} \cdot dv\right)}{\displaystyle\int_0^\infty N(v)dv}$$

The charges in transit will also gain energy from the electric field and if it is assumed that some steady state will be reached,the field gain and the lattice scattering gain must sum to zero.

Using this condition and following the argument of Smith ("Semiconductors" Cambridge Press 1959) an effective temperature for the 'hot' electrons in the depletion layer may be found, and hence a new value of mobility.

When this has been done, the continuity equation for charge transfer across the depletion layer may be solved with the corrected value of mobility. This is being considered at the moment.

PART IV

IBM 7094-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

NEW ROUTINES

D2-UOI-DRK1-45-SR

Double Precision Floating Point Runge Kutta. Solution of Differential Equations. This program integrates a set of N simultaneous, first order, differential equations in double-precision floating point arithmetic. It can be called only from a SCATRE program.

(Richard N. Porter)

D2-UOI-RKY4-46-S

Floating Point Runge-Kutta Solution of Differential Equations. This routine will solve a set of N simultaneous, first order, ordinary differential equations in floating point arithmetic. This routine should be used rather than RKY3 on a 7094 since it utilizes the 7094 double precision orders and therefore is much faster than RKY3.

Originally programmed for IBM 704 as MURKY3 by Elizabeth Z. Chapman, April 3, 1957.

(Adapted for 7094 by David Hutchinson)

During the month of September, 42 problem specifications were submitted to the IBM 7094.

539-38022 Physical Education for Men. Police Study. This problem is concerned with the prediction of "Standard-lean body weight" from four selected measurements of bone and muscle. Using this standard weight as a reference, departures from it will be used as basis for commenting on the nutritional status of a population of young police officers. Standard Scores ("Z" Scores) will be computed for each of the above predictors, together with several other physique and strength variables, and, from this data, individual profiles will be graphed.

540-38029 Economics. Canadian Money. An econometric study of the money supply of Canada is to be made. The goal of the study is to isolate the factors which determine the stock of money in the hands of the Canadian public. Extensive use is made of multiple correlation and regression analysis in this work. The use of the IBM 7094 greatly facilitates these calculations.

Most of the computation has already been completed with the use of the IBM 7090 and 7094 at the Western Data Processing Center at Los Angles. Since the existing programs were written for that particular installation revision of the Fortran decks for use at the Digital Computer Laboratory will be necessary.

541-38031 Economics. Business System Simulation. The theory of the firm has been oriented toward explaining behavior when only programmed change occurs in a system. Little has been done with the problem of explaining the behavior of firms when innovation, invention and lesser creative changes occur in a system. The present research is oriented toward this latter problem. It concentrates on the processes in the firm which generate unprogrammed change rather than on the situational determinants of change. The model which has evolved is complex and simulation appears to be the only means of studying its properties. Extensive sensitivity analysis will be run on the parameters of the system, beginning with a simple model and moving to more complex ones.

542-38030 Digital Computer Laboratory. Table of Logs. A table of logarithmic values to be used in an exponential subroutine for Illiac II will be generated.

543-39001 Agricultural Economics. Analysis of Assessment Sales Ratio on Illinois Farm Real Estate. The problem is the analysis of farmland sales data for information about real estate tax assessments in Illinois. The transformation and

correlation section of STATPAC will be used to determine the relationship between assessment ratios and size and value of tract, turnover and prices, and quality of assessment and administrative procedures.

544-39002 Psychology. Simulation of Human Discrimination. The 7094 system is to be used for the development of a simulation program for human discrimination learning. When thoroughly checked, the properties of the simulation system will be explored by systematic manipulation of parameters within the system.

545-39003 Electrical Engineering. Computer Optimization of Non-Linear Systems. The controlled dynamical system can, in general, be described by a system of first-order differential equations

$$\dot{X}_i = F_i (\overline{X}, \overline{f}, t) \qquad i = 1, 2, \ldots, n$$

where $\overline{X}$ and $\overline{f}$ stand for the set of variables $X_1, X_2, \ldots, X_n$ and $f_1, f_2, \ldots, f_m$, respectively, and the functions F are continuous and differentiable in X and f. The set of variables $\overline{X}$ is called the state variables as it specifies the dynamical state of the controlled system. The set of variables $\overline{f}$ represents the control forces available. The n-dimensional space with the X_i's as coordinates is called the phase space. Each point in the phase space represents a dynamical state of the system.

A straight analytical solution of the above optimal-path problem is non-existent but it is possible to utilize the IBM 7094 computer for approximate optimum control as follows:

The optimum trajectories are computed from the equations describing the system using either dynamic programming or digitized maximum principle. These trajectories together with the corresponding control forces $\overline{f}$ (t) are stored.

The stored data are then utilized in one way or another to control the system. Three basic types of computer control to be used are input control, programming and perturbation correction, and digital feedback system.

546-39004 Agricultural Engineering. Intake Manifold Analysis. This problem deals with the analysis of air pulsations in the intake manifold of internal combustion engines. Experimental work has been done with one-cylinder operation, and by use of Fourier analysis, an equation of the form y = f (x) was fitted to the experimental curve.

By use of the proper phase angles, the resultant pressure curve for 2, 3, 4, 6, and 8 cylinders is to be determined. These curves will then be compared with experimental results for 2, 4, 6 and 8 cylinder operation.

547-39005 Physics. Testing of Polar Plot Sub-Routine. This computer time in the immediate future will be used to code-check subroutines which have been written such as the one which does polar plotting, another which does three dimensional relocation methods in Cartesian coordinates, etc. The main part of this time, however, will be used in processing data collected in physics courses.

548-39006 Aeronautical and Astronautical Engineering. Reactive Gas Dynamics. This problem will be used for preliminary analysis of the feasibility of experimentally studying elementary gas dynamics in a reactive gas. The problem will be algebraic in nature and will involve solving for equilibrium compositions in a simple system and determining the fundamental properties of these systems.

549-39007 Aeronautical and Astronautical Engineering. Shock Tube Operation. This problem number will be used to process relatively simple problems and construct operating tables for the shock tubes in the Aeronautical and Astronautical Engineering Department. As such it will be useful in graduate research, undergraduate research, and for laboratory undergraduate class work.

550-39008 Mechanical Engineering. Eulerian and Lagrangian Statistics. From the motion of finite solid particles in suspension in a turbulent fluid and from the knowledge of diffusion data of a stationary and isotropic velocity flow field, the lagrangian statistics (displacement conditional variance) of the fluid (in the binary system) is calculated from the lagrangian statistics (moments) of the solid particle. Let the random variables X and Y be the displacements of the solid and of the fluid particles respectively, then the connection between the diffusion data $E(Y^2)$ and the corresponding statistics of the binary fluid $E(Y^2|X)$ is given by

$$E(Y^2) = \int E(Y^2|X)\, f(X)\, dX$$

The computer program consists of: a) Least squares polynomial approximation to $E(Y^2|X)$, $E(Y|X)$ and $E(X|Y)$. b) Calculation of moments of X c) A taylor series expansion of the lagrangian correlation coeffecients in terms of Eulerian Correlation coefficients and calculation of the coefficients of the polynomial from the above diffusion results. d) calculation of $E(X^2|Y)$ from the stochastic equation of motion of solid-fluid system.

551-39009 Biophysics. Permotron Simulation #1. This thesis consists of a study of a simplified model of the human nervous system, a model which attempts to explain a large variety of previously uncorrelated neurological and psychological facts. The model takes the form of a machine which is called a "Permotron"- in order to emphasize that the machine's specifications were developed under the constraint of attempting to guarantee permanent memory properties in a model of the human brain where it has always previously been the case in such models (which must show learning behavior at all or most times) that there is no guarantee of any permanent memory properties.

This program simulates the behavior of a simple Permotron and determines the rate of learning as a function of time. It is hoped that the machine's properties are such as to guarantee that its finite learning capacity is properly distributed throughout the "life time" of the machine.

552-39011 Digital Computer Laboratory. Disk File Orientation. This problem will be used to gain experience in disk file operation for the purpose of applying this experience to the writing of programs on ILLIAC II for check out and testing of the ILLIAC II disk file system.

553-39014 Psychology. Analysis of Variance I. A questionnaire was administered to 138 subjects. One part of the questionnaire classified the subjects along three dimensions each with three levels. This yields 27 types or categories of subjects. The subjects then were presented with 64 hypothetical job situations composed of the combinations of 4 factors, 3 of which had 2 levels and the 4th had 8 levels. The subjects were asked to rate these jobs on a scale ranging from -4 to +4 in integral steps with no zero point. These ratings are to be the criterion measures for an analysis of variance. The ratings are to be converted to standard scores for each of the subjects. Once they are in this form, four way analysis of the variance in these criterion measures due to the 4 factors of the job stimuli will be done. The analyses will be concerned with the interactions of the factors and tests of their significance. There will be one analysis for all 138 subjects, and one for each level of the original dimensions of classification which were: personality - 3 types; choice of residence - 3 choices and socioeconomic background - 3 levels, making 10 analyses in all.

554-39016 Physics. Music Generator. The computer will be used to generate random digits ≥ 63 representing 5 octaves. Through an increasingly sophisticated series of testing procedures representing in mathematical form the Laws of Melodic, and later Harmonic Progression, an attempt will be made to generate a music-like array of notes. Later harmony and counterpoint will be undertaken. The testing procedures must be positionally dependent. The library routine RAMIB will be used.

555-39017 Mechanical Engineering. Vibrational Nonequilibrium Flow. A computer program has been written to solve the one-dimensional equations for vibrational non equilibrium flow through a hypersonic nozzle. The solution is by increments and involves only the ordinary isentropic flow equations and the Rayleigh heat addition equations.

556-39019 Physics. Miscellaneous Subroutines. The computer will be used to develope and study several useful routines: Simultaneous Linear Equation Solver using Gausien Elimination, General Differential Routine for f (x) where $f(x) = \frac{f(x+h) - f(x)}{h}$, General Differential Routine using an approximating function for $f(x) = a + bx + cx^2$.... and formally differentiating, A program to Solve Poisson's Equation by the method of minimization of residues, A general Root Finder, A Formal Differentiating Routine.

557-39021 Psychology. MMPI Test Scoring. Given a set of L items which have been agreed or disagreed with (1 or 0) by N subjects, the problem is to combine subsets of the items into "scales" by reference to a predetermined pattern of responding, given by test "keys" in such a manner that all subjects receive scores on the scales of interest. This is accomplished by a test scoring program already prepared.

The subjects' scores on the above scales are then entered into a product-moment correlation routine, followed by a principal axis factor extraction and Varimax rotation program.

558-39022 Electrical Engineering. Filter Synthesis. The application of usual network synthesis methods to the problem of realizing transfer functions with many zeros and poles usually involves numerous calculations and necessitates the use of a high speed computer. Most of these methods involve zero shifting which enhances the propagation of errors associated with the numerous arithmetical operations. For

a large class of network problems it is possible to fix the topology as well as the element types in the various branches. The computer may be used to adjust the various element values until the network specifications are met. For this class of problems the latter approach may yield more satisfactory results.

The adjustment procedure will be some modification of the method of steepest descent to minimize the difference between the actual response and the desired response. Direct search and other minimization procedures will be tried also.

559-39023 Electrical Engineering. Cryptographic Analysis. The computer will be used to compare two lists of coded information in an effort to find the most likely combinations. The code is a simple transposition an example of which is below.

7 1 6 2 4 3 5	1 2 3 4 5 6 7	1 2 3 4 5 6 7
EXAMPLE OF WHICH	A E H F C P E	M Ø I W H L X

When such a list is split up, and one half is matched with the other, the total sum of the probability of each pair of letters occurrence is very large when the proper pairing is found. The probability is obtained from a reference table.

Example:

A B C D A E H F C P E A B C D
M Ø I W H L X

$P+P+P+P+P+P+P = P_T$

P is the probability of each pair occurring.

P_T is the total probability which is large for the correct pairing.

After each comparison, the bottom list is shifted right one letter. In this case "P_T" is largest when the "M" is under the second "A".

560-39025 Digital Computer Laboratory. ISING Lattice. The present program is designed to employ computer techniques on the Ising lattice problem in physics. Initial spin configurations are entered by subroutine, and spin-flipping follows according to the laws of probability. This program in its present form is completing several hundred cycles for a given temperature in 2-dimensional space. Future plans include the expansion to a 3-dimensional cubic lattice, the testing of various imposed boundary conditions, and the determination of specific heats, etc., in addition to the present energy/site calculation.

561-39027 Physics. Phase Shift Analysis. The problem is a phase shift analysis of the angular distribution in pion-nucleon scattering, in which the phase shifts corresponding to higher angular momenta are held fixed and determined by the Mandelstam representation. The phase shifts for lower angular momenta, which are to be varied, can be considered as forming a vector X in an n dimensional space. If Ye (I) and Δ Ye (I) are experimental value and experimental error for the differential cross section at angle I, and Yt (I) the calculated value which depends on X, the problem is to minimize

$$\chi^2 = \sum_I \left(\frac{Ye\ (I) - Yt\ (I)}{\Delta Ye\ (I)}\right)^2$$

as a function of X. The minimization is performed by numerically calculating partial derivatives of χ^2, and then varying X by an increment along grad χ^2. This step is repeated until an X is found for which χ^2 has a relative minimum. An error analysis requiring second partial derivatives of χ^2 at the minimum is included.

562-39029 Agricultural Economics. Vertical Integration Via Input-Output. This routine will be used as a means of determining the economically independent sub-systems producing for final (non-inter-industry) demands only. The fractions of resources of each industry belonging to each sub-system will be calculated.

563-39030 Astronomy. Cluster Models 1. This program computes configurations for spherically symmetric self-gravitating stellar systems. It starts with assumed velocity distributions for up to ten different stellar types, integrates the velocity distributions to get density as a function of potential, solves Poisson's equation to find the spatial densities, and projects the result onto the plane of the sky for comparison with observation.

The computation makes several quadratures by means of Simpson's three-point and four-point rules. The Poisson calculation involves a second-order ordinary differential equation; the solution is started by an iteration on the first four points and continued by Hamming's method.

564-39031 Civil Engineering. Quantity Take-Off. This program is of the nature of an informational retrieval problem. It involves the calculation of quantities of operations required in the construction of any physical structure. It will involve the development of numerous special purpose subroutines which will be linked through a master program. A call system will be developed to select the required subroutines efficiently.

565-39034 Business Administration, Graduate School. Petroleum Game. The purpose of this project is to use the IBM 7094 to construct a Business Game. The game will simulate the petroleum industry. Five oil companies and 6 marketing areas will comprise the industry with each company being able to make up to 6 separate products.

Each company's management will be played by a team of students. Marketing and Production decisions will be made by the students.

One play of the game will build on the last play of the game to construct entire business periods.

566-39037 General Engineering. Automatic Process Design. In an Automatic Process Design for fabrication with metal cutting tools this program will determine the positioning of the workpiece, the machining dimensions and tolerances. These data are compared to a specific set of machine and tool capabilities and suitable equipment is selected. Machinability relationships are used to determine feeds, speeds, tool geometry and cutting time. The output is equivalent to a routing sheet including setup data and a time standard. The current program is limited to the turning process.

567-39038 Psychology. Uncertainty Preference. The aim of the research is a specification of preference of human subjects for stimuli which vary in their predictability of construction. The experimental procedure used to scale the items for preference is the classic paired-comparison technique. This method requires varying orders of presentation, several pairs of comparisons, the transformation of frequencies to proportions, another transformation of the proportions to normal deviates, and the summing of these deviates. The computational labor and probability of error involved in human processing of these data make the research impossible without machine processing.

Through the use of the 7090 IBM computer the processing time from collection to survey of the finished results is cut, allowing decisions as to the next research design to be made with all available information from previous work.

568-39039 Physics. Transport. The 7094 will be used to investigate the feasibility of programming grammar school and high school student distribution between several schools. The particular problem is that involved in chosing who shall ride to school and who shall walk to school. Distances are determined by table look-up which involves using only a students address.

569-39040 Civil Engineering. Response Operators. This problem computes the theoretical and experimental response operators of a construction-type barge as moored in an irregular undirectional seaway. The time series of heave, pitch, sway, roll, yaw, surge, mooring line tensions and water level variation are used as the initial data to compute the spectra, cross-spectra, phase and coherencies from which the experimental response operators are determined. Mapping routines for the auto-correlation coefficients, spectra and coherencies are included.

Coupling of the transverse motions (sway, yaw and roll) and the longitudinal motions (pitch, heave and surge) result in two - 3 x 5 complex matrices which contain the six differential equations of motion necessary to compute the theoretical response operators. The slender body theory is utilized to evaluate orbital particle wave velocities and the linear theory of the ship's motion is a basic assumption in the formulation of the equations of motion. Subroutines for matrix inversion and adaptation of the Hamiltonian equation are provided for conversion to shallow water conditions.

570-39041 Chemistry and Chemical Engineering. Force Calculation. The problem is the calculation of the potential energy constants for the Hydrogen Fluoride molecule, using recently published accurate self-consistent field wave functions. Rather than to calculate the potential curve from the energy of the molecule at three values of internuclear distance, it is proposed to calculate the force on each nucleus directly. This requires evaluation of the matrix elements of the force operator F between the various basic functions used, which leads in turn to one-electron integrals in ellipsoidal coordinates of the form

$$f_{p\,q}^{(a,b)} \equiv \int_1^{\infty} d\lambda \int_{-1}^{1} d\mu \; \lambda^p \mu^q e^{-a\lambda} e^{-b\mu} \quad \frac{1-\lambda^2}{(\lambda+\mu)^2} + \frac{\lambda}{\lambda+\mu}$$

where a and b are constants, p and q are integers, λ and μ are the coordinates defined as:

$$\lambda = \frac{1}{2R} \; (r_A + r_B), \; \mu = \frac{1}{2R} \; (r_A - r_B).$$

Here, R is the internuclear distance, and r_A and r_B are distances to the nuclei A and B, which serve as foci of the coordinate system. These integrals are generated for each set of constants (a,b) by use of recursion relationships. The computer will be used to calculate sets of $f_{p,q}$ (a,b) for various values of a and b, and later to combine these integrals into the matrix elements of F. The recursion relations require summing of infinite series, and evaluation of exponential integral functions, logarithms, and exponentials.

571-39042 Physics. P-P Scattering and Bound States. The IBM 7090 is to solve two sets of linear homogeneous simultaneous systems of 16 equations each. These equations arise in the problem of P-P scattering when crossing symmetry is applied to the invariant function multiplying the tensor of the fourth rank in the invariant Feynman amplitude.

572-39043 Physics. Extremely Low Energy Electron-Helium Collisions. The complex microwave conductivity of Helium afterglow plasmas created in a parent gas immersed in liquid Helium has been measured over the pressure range 1/10 to 6 mmHg at 4.2°K. In addition, electron energy relaxation times have been measured by means of cross modulation techniques.

The theoretical expressions for the associated collision frequency for momentum transfer and energy relaxation time involve integral equations whose variable parameters are to be fitted by numerical integration. Results should give information on multiple scattering of extremely slow electrons by dense charge neutral scatterers.

573-39044 Economics. Socioeconomic Factors in Banking. Banks in medium and large size cities in the United States will be analyzed on a cross section and time series basis to determine the effects of the non-banking economic factors of the community on the important variables of the banks. Economic characteristics used will include the nature of industry in the community, population, family income, and marketing area served. Banking variables will include amounts of loans, investments, and deposits of the bank. Modified forms of generalized multiple regression analysis will be used.

574-39045 Civil Engineering. Evaluation of Low-Cycle Fatigue Data. The program is constructed to obtain a "best fit" theoretical curve corresponding to a series of data points obtained from low cycle fatigue tests of various metals. This curve is obtained by computing the per cent error between actual laboratory data and the theoretical prediction for all data points within the scope of a given test series. By incremental alteration of a constant term in the formulae involved, the computer will thus arrive at the theoretical curve which best represents the physical data.

575-39046 Digital Computer Laboratory. Information Retrieval. The aim of this research problem is to develop a program for retrieval of information from English text. With key words and certain ancillary information as input this program is to locate those documents in which the key words appear subject to the conditions (word frequency, etc.) specified in the ancillary information.

576-39047 Chemistry and Chemical Engineering. Statistics of a Line. The standard formulas for calculation of the statistics of a "straight" line are used. The regression line is calculated assuming errors in $X \ll Y$. The coordinates of the points $(x,y)_i$ forming the line, the number of points (N), and the relative weights of each point (optional) (W_i) are input. The slope and intercept of the regression line, and their standard deviations, the standard deviation(s) of the points from the line along the Y axis, the correlation coefficient, $(x,y)_i$, W_i, and N are output.

577-39049 Mathematics. Integration. The problem is to determine effective techniques for evaluating, numerically, integral transforms. Krylov's book on Numerical Integration is the main source of the various techniques that will be tried.

578-39053 Mining, Metallurgy and Petroleum Engineering. Design of Underground Openings. Stresses at interior points in rock surrounding a cavity will be calculated and then various criteria of failure applied to determine the stability of various size and shaped openings under various conditions of loading. Analytical solutions for stresses under elastic and plastic-elastic conditions will be used. These solutions are generally extremely long and cumbersome and are in terms of various coordinate systems. Programs will be written to transform the solutions into an x-y coordinate system and to solve the stresses at any given point.

579-39054 Mechanical Engineering. Supersonic Ejectors. An analysis of the operating characteristics of ejectors with a supersonic primary stream will be made for conventional and annular ejector systems. The method of analysis consists of combining the inviscid and viscid flow components.

The inviscid solution is based on a simultaneous numerical solution of the equations for axisymmetric potential flow by the method of characteristics (primary stream) and the one-dimensional equations of gas dynamics (secondary stream).

The final ejector flow solution is obtained by superimposing the viscous mixing flow component on the inviscid solution.

580-39055 Bureau of Economic and Business Research. Forecasting U.S. Economy. Multivariate methods will be used to establish relationships needed for forecasting changes in a complex system. Single-equation regressions will be derived for a number of important variables. Some of these will then be incorporated in an annual forecasting model for the economy as a whole. Alternative models will be tested to determine forecasting accuracy and to resolve problems encountered in their use -- for example, to minimize reliance on autonomous projections. The best of the annual models will then be adapted for quarterly projections, and promising variants will again be put through a series of tests to evaluate their merits in different forecasting situations.

During the month of September, 8 instructional problem specifications were submitted to the IBM 7094.

I74-39010 Aeronautical and Astronautical Engineering 216. Steady Flow Gas Dynamics. The program will be used to solve some of the more complicated compressible flow problems to illustrate to the student the use of computer techniques. The student will be asked to further reduce the machine output. Only algebraic techniques will be used in this program.

I75-39012 Economics 374. Economic Forecasting. Standard multiple regression analysis is to be used by students to forecast in various sectors of the economy as a class project in Economics 374.

I76-39013 Civil Engineering 497. Building Frame Stability. This problem consists of the development of a method of attack for the study of the stability of a rigid building frame subjected to a series of different loads each large enough to produce some plastic yielding.

Among other things, this will require matrix inversion, the calculation of deflections throughout member lengths, and special provisions to take into account residual stresses in members. The problem is too complex and involves too much numerical work to be successfully undertaken in any reasonable length of time without the aid of the computer.

I77-39015 Agronomy 365. Problems. Application of Computers to Statistical Problems. Students in the course will write programs for at least 5 statistical problems. Three of these are to be assigned by the instructor. The remainder will be selected by the students from their own areas of interest. It is expected that problems will deal with the following topics: Analysis of variance, multiple linear regression, correlation, multivariate analysis, and non-linear least squares.

I78-39020 Chemistry and Chemical Engineering 381. Chemical Engineering Plant Design. Some modern mathematical and computational methods will be introduced in this course and employed to carry out parametric studies and optimizations on the IBM 7094. Problems assigned will be similar to situations of current interest in the chemical process industries.

I79-39048 Chemistry and Chemical Engineering 490. Problem 1. Chemistry Short Course--7094. Write a program to read a number Y from a card with format E15.10 and print Y and X, where X is the solution of the equation:

$$Y = x^2 + e^X + \sin(X/2)$$

Use the iteration method discussed in class. Assume $1 \leq Y \leq 100$ and find $X \geq 0$.

I80-39051 Mining, Metallurgy and Petroleum Engineering 353. Problems. Class problems pertaining to the statistical analysis of sample data from mineral deposits including calculations as to size (volume, tonnage) as well as grade will be run.

I81-39050 Mechanical Engineering 342. Problem 1. 4-Bar Linkage. This program will be used to calculate the angles of the links made with the horizontal as the driving link moves through a complete cycle of motion. Standard subroutines will be used. The length of the 4 links will be arbitrarily determined before the problem is run and will be part of the input data.

TABLE I - IBM 1401 - I

SUMMARY OF USE

September, 1963

Scheduled Engineering	2:00
Unscheduled Engineering	5:15
Maintenance	7:25
7094 Preparation	355:49
Listing	21:03
Tape Dump	42:18
Tape Tests	21:11
Reproduce	5:05
Code Checks	9:19
Tape Labelling	:10
Idle	30:47
Total Running Time	500:22

TABLE II - IBM 1401

SUMMARY OF MACHINE ERRORS

September, 1963

1401 Processing Unit	1
1403 Printer	3
729V Tape Units	3
1402 Read-Punch	2
Total	9

TABLE III-September, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURE	IBM 1401-I DAILY DISTRIBUTION TIME
9/3/63	16:52			:10		17:02	1	(1) Process errors
9/4/63	21:25	2:00	:35			24:00	1	(1) Inspected 1403, cleaned type chain, and repaired cover. Cleaned friction clutches on ribbon drive. 1402 reader will not read cards.
9/5/63	23:30		:15	:15		24:00	1	(1) Card jam in 1402 punch.
9/6/63	23:28			:07	:25	24:00		
9/7/63	17:15				:15	17:30	1	(1) Tape unit A failed to rewind after reading EOF mark
9/8/63	9:30					9:30	1	(1) Fuse blown on tape unit A. Replaced
9/9/63	14:25			:20	1:15	16:00		
9/10/63	23:45			:15		24:00		
9/11/63	23:30			:30		24:00		
9/12/63	22:45			:25	:50	24:00		
9/13/63	17:55			:25	5:40	24:00		
9/14/63	7:20				3:10	10:30		
9/15/63	:05					:05		
9/16/63	15:40			:20		16:00	1	(1) Column 33 misses printing randomly on 1403 printer.
9/17/63	22:45			:35	:40	24:00		
9/18/63	22:20		:50		:50	24:00	1	(1) Replaced hinges on door and put new form type guide on 1403 printer,
9/19/63	23:16			:15	:29	24:00		
9/20/63	20:23			:50	2:47	24:00		
9/21/63	9:00					9:00		
9/22/63	1:00					1:00		
9/23/63	15:15			:25		15:40		
9/24/63	23:37			:23		24:00		
9/25/63	19:19			:30	4:11	24:00		
9/26/63	20:30			:25	3:05	24:00		
9/27/63	16:20			:30	7:10	24:00		
9/28/63	12:05			:30		12:35	1	(1) Fuse out in tape unit A. Replaced by engineer
9/30/63	11:40		3:35	:15		15:30	1	(1) 1402 read-punch will not read program. Blown fuse in power supply; also found faulty power driver.
TOTALS	454:55	2:00	5:15	7:25	30:47	500:22	9	

During the first part of September, 1963, a second IBM 1401 computer was delivered, installed, and checked out. It became available for use on September 25.

TABLE I - IBM 1401 - II

SUMMARY OF USE

September, 1963

Scheduled Engineering	3:30
Maintenance	:40
7094 Preparation	34:50
Code Checks	3:37
Reproduce	1:05
Listing	4:15
Tape Dump	2:30
Idle	29:03
	79:30

TABLE III-September, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURE	IBM 1401-II DAILY DISTRIBUTION TIME
9/25/63	12:10	3:30			:20	16:00		Installation of 1401
9/26/63	8:37				6:53	15:30		
9/27/63	11:00			:10	12:50	24:00		
9/28/63	:15				7:45	8:00		
9/30/63	14:15			:30	1:15	16:00		
	46:17	3:30		:40	29:03	79:30		

TABLE I - IBM 7094

SUMMARY OF USE

September, 1963

Scheduled Engineering	50:06
Unscheduled Engineering	10:32
System Updating	2:32
Production	590:03
Operator Manipulations	66:47
Total Running Time	720:00

TABLE II - IBM 7094

SUMMARY OF MACHINE ERRORS

September, 1963

Central Processing Unit	1
7302 Core Storage Unit	1
Channel A	1
1301 Disk File	2
Cathode Ray Tube	2
711 Card Reader	1
	8

TABLE III-September, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	OPERATOR MANIPU-LATION	TOTAL RUNNING TIME	ERRORS	IBM 7094 DAILY DISTRIBUTION TIME
9/1/63	24:00				24:00		
9/2/63	24:00				24:00		
9/3/63	19:34	2:00		2:26	24:00		
9/4/63	16:31	1:45		5:44	24:00		
9/5/63	19:48	2:07		2:05	24:00		CRT was brought back on line after tubes were checked and diagnostic tests run.
9/6/63	18:42	2:00		3:18	24:00		
9/7/63	21:02			2:58	24:00		
9/8/63	24:00				24:00		
9/9/63	19:17	2:00	:15	2:28	24:00	2	(1) Core storage unit dropped power. Turned back on and ran OK. (2) CRT not functioning properly. Stops after taking 50 frames. Fixed flipper switch in core storage unit. Balanced the CRT.
9/10/63	18:47	2:00		3:13	24:00		
9/11/63	19:47	2:25		1:48	24:00		
9/12/63	18:12	2:40	:50	2:18	24:00		
9/13/63	18:03	2:56		3:01	24:00		
9/14/63	24:00				24:00		
9/15/63	24:00				24:00		
9/16/63	20:14	2:00		1:46	24:00	1	(1) CRT taken off-line. CRT was tested and two tubes were re-placed. The CRT was put back on-line.
9/17/63	19:08	2:20		2:32	24:00		
9/18/63	19:02	2:00		2:58	24:00		
9/19/63	17:44	2:05	1:32	2:39	24:00	1	(1) Engineering on 1301 Disk File. Having trouble with module '0' and 1 reading and writing.
9/20/63	16:36	2:00	2:05	3:19	24:00	1	(1) Same as above.
9/21/63	22:35			1:25	24:00		
9/22/63	24:00				24:00		
9/23/63	19:22	2:12		2:26	24:00		
9/24/63	18:38	2:25		2:57	24:00		
9/25/63	17:38	1:20		5:02	24:00	1	(1) Card reader not functioning properly. Trouble found in channel A next day.
9/26/63	12:41	2:10	4:50	4:19	24:00	1	(1) Channel a giving trouble. Had card was found. Installation of hardware monitor. Ground devel-oped on CPU and, also, a bad card.

TABLE III-September, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	OPERATOR MANIPU-LATION	TOTAL RUNNING TIME	ERRORS	IBM 7094 DAILY DISTRIBUTION TIME
9/27/63	10:48	9:06		4:06	24:00		
9/28/63	23:06			:54	24:00		
9/29/63	24:00				24:00		
9/30/63	17:20	2:35	1:00	3:05	24:00	1	(1) Check sum errors. Illegal BCD card errors. Bad transistor card found and replaced in 7109 arithmetic unit.
	592:35	50:06	10:32	66:47	720:00	8	

TABLE IV - IBM 7094

USE BY DEPARTMENTS - SEPTEMBER, 1963

DEPARTMENT	Number of Runs: Class	Number of Runs: Research	Number of Runs: Non System	Total Number of Runs	Number of Problem Specifications: Class	Number of Problem Specifications: Research	Number of Problem Specifications: Non System	Total Number of Problem Specifications	Total Time Used: Class	Total Time Used: Research	Total Time Used: Non System	Total Time Used
Aeronautical and Astronautical Engineering	10	36		46	1	4		5	:08	:42		:50
Agricultural Engineering		120		120		4		4		3:35		3:35
Agricultural Economics		91	18	109		8	3	11		8:11	14:05	22:16
Agronomy	12	181		193	1	12		13	:05	3:35		3:40
Animal Science		18		18		3		3		:31		:31
Astronomy		16		16		2		2		:07		:07
Bureau of Economic and Business Research		61		61		2		2		1:46		1:46
Biophysics		8		8		1		1		:20		:20
Civil Engineering	20	840		860	2	39		41	:14	26:55		27:09
Chemistry and Chemical Engineering	3	794		797	1	35		36	:01	31:59		32:00
Communications		62		62		1		1		:24		:24
Center for Zoonoses Research		5		5		1		1		:01		:01
Digital Computer Laboratory	55	505	11	571	1	19	6	26	:47	9:19	2:36	12:42
Dairy Science		31		31		2		2		:43		:43
Economics		14		14		2		2		:36		:36
Education		53		53		4		4		1:50		1:50
Extension, Division Counseling		1		1		1		1		:01		:01
Electrical Engineering	14	325		339	2	17		19	:08	5:48		5:56
Forestry		19		19		2		2		:52		:52
Food Technology		9		9		1		1		:07		:07
Business Administration, Graduate School	2	5		7	1	1		2	:03	:11		:14
Institute of Communications Research		4		4		2		2		:16		:16
Industrial Education		2		2		1		1		:04		:04
Instructional TV		35		35		2		2		1:07		1:07
Institute for Research on Exceptional Children		4		4		2		2		:37		:37
Law		1		1		1		1		:01		:01
Mathematics	619	1		620	2	1		3	1:31	:01		1:32
Mechanical Engineering		326		326		16		16		8:42		8:42
Marketing		1		1		1		1		:05		:05
[illegible]		80		80		2		2		1:28		1:28

TABLE IV - CONTINUED

DEPARTMENT	Number of Runs			Total Number of Runs	Number of Problem Specifications			Total Number of Prob. Specs.	Total Time Used			Total Time Used
	Class	Research	Non System		Class	Research	Non System		Class	Research	Non System	
Men's Residence Hall Association Rocket Club		44		44		1		1		1:18		1:18
Nuclear Engineering		101		101		3		3		3:15		3:15
Office of Instructional Research		26		26		1		1		:39		:39
Physical Education for Men and Graduate Physical Education		4		4		1		1		:22		:22
Physics		1102	63	1165		25	1	25		30:52	382:16	413:08
Plant Pathology		1		1		1		1		:01		:01
Political Science		10		10		1		1		:44		:44
Psychology		301		301		25		25		19:20		19:20
Psychiatry		13		13		1		1		:22		:22
Sociology		33		33		1		1		:14		:14
Statistical Services Unit		355	2	357		1	1	2		10:33	:25	10:58
State Water Survey		171		171		7		7		4:21		4:21
Theoretical and Applied Mechanics		98	1	99		6	1	7		3:24	2:00	5:24
Sub Totals	735	5907	95	6737	11	263	12	286	2:57	185:19	401:22	589:38
Instruction		39		39		1		1		:25		:25
Grand Totals	735	5946	95	6776	11	264	12	287	2:57	185:34	401:22	590:03

PART V

GENERAL LABORATORY INFORMATION

Colloquium

"Transistor High Voltage Effects," by Dr. L. Van Biljon, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, September 30, 1963.

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	15	1	15.5
Visiting Faculty	2	2	3.0
Research Associates	3	0	3.0
Graduate Research Assistants	1	52	16.8
Graduate Teaching Assistants	0	5	1.1
Professional Personnel	4	3	5.5
Administrative and Clerical	9	0	9.0
Other Nonacademic Personnel	46	64	71.6
Total	80	127	125.5

The Computer Advisory Committee consists of Professors H. C. Brearley, J. R. Ehrman, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During September a total of 104 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	7	5
Medium Drawings	3	0
Small Drawings	2	7
Reports	13	0
Change orders	0	0
Printed Circuits	0	0
Miscellaneous	67	0
TOTAL	92	12

(K. C. Law, P. Richardson)

Physics

DIGITAL COMPUTER LABORATORY

UNIVERSITY OF ILLINOIS

URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM

PART II - ILLIAC II SYSTEM PROGRAMMING AND OPERATION

PART III - CIRCUIT RESEARCH PROGRAM

PART IV - IBM 7090-1401 SYSTEM

PART V - GENERAL LABORATORY INFORMATION

OCTOBER 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. New Construction--Electronics Shop

In terms of transistor counts, the following progress has been made during October.

Chassis Wired and Inspected	68
Printed circuits (343 cards)	807
Printed circuits repaired (6 cards)	
Printed circuits modified (22 cards)	

(F. Serio)

2. New Construction--Mechanical Shop

A new scheme for mounting cover panels on the machine was evolved and reduced to practice on the core and drum boxes. Though the general results seem satisfactory, an attempt is in progress to obtain more rigid metal-clad material for use as panels.

It is perhaps stressing the obvious to state that the machine covers were painted and the display panel completed.

The printed circuit facility processed in all 4 board layouts and 399 complete boards, 2 layouts and 189 boards being destined for ILLIAC II installation.

(T. E. Kerkering)

3. Circuit Book

A few minor changes were made in the circuit book and plans for a complete overhaul of the book during November were made. There seems to be some difficulty distinguishing ILLIAC II and ILLIAC III

circuits since neither book labels individual circuits (eg., $\bar{0}_a$) with the identifying number. Some solution to this will be generated.

A listing of all the boards on which a given circuit appears, is being prepared.

(D. Collins)

4. Component Testing

Another life-tester for diodes has been completed. This tester incorporates a visual indicator of voltage changes in the diode string of more than about 0.25 volts. This will be described in a file number to be prepared shortly.

(B. Doden, J. Smith)

Approximately 13,000 diodes were acceptance tested including 7000 1N995 and 5700 TI55. Acceptance tests were also run on about 6500 transistors of assorted types.

Data taken on 2N967 type transistors of various manufacture showed a high yield on BETA > 150 at 200 ma. These units will be green dotted for possible use in cable driving circuits.

(B. Doden)

5. Preventative Maintenance

A. Routine Inspection of NJE Power Regulators

In order to trace the cause of spurious power trips and drifting sense signals from the over/under voltage detectors, a ritualistic bi-weekly inspection of voltages has been initiated. Insufficient data is yet available for any conclusion to be drawn.

(L. Byers)

B. Routine Inspection of Signals

The program of oscilloscopic observation of signals continues with the initial examination of Interplay Control. The check was made on restoring circuit collectors, peripheral signals, and a sample of restored signal outputs, using the Block Transfer Check (B.T.C.) program.

Table I. Collector Overshoot

Chassis		Transistor Number
CE10	→	199
		147
CE9	→	154
		36
		78
CE8	→	33
		69
CE7	→	7
CC4#1	→	42
CC16	→	42
		74

Table II. Open Diodes

Chassis	Transistor Number
CE9	134
CE1	61
CD20	106
	108
CD18	170
	69
	175

Other Points of Interest

CE9, pin B22, $\overline{\text{MRA}}$ is only 60 nsec positive

CE8, L22 $\overline{\text{1PC3A}}$, 150 nsec, negative

CC4, The $\overline{\text{C4}}$ cable drivers into these chassis have 2 v overshoot.

CD4#4, Collectors of 89 and 90 have no -5 for the bump. The jumper is missing.

CD2#3, pin T9 is at ground while the same pin on CE2 is not.

CC15 }
CD15 } $\overline{\text{OWi}}$ bits are overshooting ground from 1/4 to 3 volts.
CD16 }

CC15, pin B7 is bouncing back to ground after going negative

CD18, pin R26 rings quite a bit upon going negative.

(L. Byers, C. E. Carter)

6. Console Construction

All existing machine controls including the paper tape equipment have been completely shifted to the new console.

All mechanical work on the console seems to be complete. Six door racks capable of handling 540 cards have been installed complete with cooling fans. An attempt has been made to facilitate maintenance and inevitable changes by equipping the majority of console mounted assemblies with plugs. One important feature of this policy is wiring of the console control panel as a set of small plug-in assemblies. Accordingly, changes of control configuration dictated by hindsight should be unusually convenient.

(R. Kingsley, H. Lopeman, A. Sadler)

7. Magnetic Drum Memory

Checkout of the Drum Memory using the 32K fixed head drum (Serial 129) continues. Many hours of test programs were run. Some heads were readjusted, and adjustments were made in the electronics. The temporary digit clocks, which had been in use for several months, were copied from the temporary to the permanent locations. Power supply voltage marginal checks were run; most voltages stood the standard $\pm$ 10 percent variations, a few caused errors beyond $\pm$ 8 percent.

Two more stringent drum test programs are being written and debugged. One of these bombards each block in one band with writes and reads at the maximum rate. The other varies the duty cycle of write and read commands over a wide range. The aim of both is to find if the drum error rate depends on the frequency of write and read commands.

(H. C. Brearley, R. A. Marlett,
R. L. Miller, F. A. Rohatsch,
G. Cooper)

8. IBM 1414 Interplay Channel

Checkout is 90 percent complete and should be finished shortly on the first magnetic tape channel. Initially, the 1401 will have four tape drives, the 1414 will have one, and two tape drives will be switchable between the 1401 and the 1414. Wiring is underway on the other three 1414 channels. A report on programming for the 1414 channels has been started.

(M. J. Pisterzi, R. Willard, H. Lopeman)

9. Console I/O Typewriter

The internal logic of the IBM Selectric has been analyzed and design is started for adding the Selectric onto ILLIAC II as Special Register 76_8.

(H. Hsu, D. Tabak)

10. IBM 729 Modification

A method was devised to force the tape drives into a File Protect status, independent of the presence of a File Protect Ring, under the control of a console-mounted toggle switch. This has been installed on the 729's used by the 7094-1401, and will be added shortly to those on ILLIAC II.

(R. E. Willard)

11. Interplay Control

Channels 0 to 15 are now operative.

(G. Krabbe)

12. Engineering Test Console Interplay Channel

Checkout using the device simulator has been completed. Further progress awaits wiring of coupling circuits to the Test Console.

(G. Yen, S. P. Krabbe)

13. Drum Special Registers

SR02 and SR04 are now checked out.

(S. P. Krabbe)

14. Switch Special Register

The simple input-oriented switch register has been reassigned from SR06 to SR34.

Special Register SR06 will become an elegant special input/output facility for 13-bit communication to any general plug-in device. A set of switches and lights included will facilitate manual input/output from the console. It is expected that the input/output facility will be used only during specially assigned times and that console operation would be the normal mode. Additional registers of this type may be built to account for any future large demand.

Logic design is complete and wiring has begun.

(J. Bouknight)

15. Engineering Test Program

The Random Number Generator program has been subjected to a series of tests for the randomness of the numbers formed. Results of a frequency test, poker test, and run test are satisfactory and will be described in a report now in preparation.

(D. Chow)

A collection of EST subroutines, rewritten to make them compatible with System II, has been issued as "Symbolic EST," P1-SEST-57v. Subroutines may be addressed symbolically, and operation in the interrupt mode is possible.

(M. Levin)

A program to test the shift orders SRS, LRS, and BLS has been completed and issued as P1-SFT-55v.

(L. Huszar)

Test Programming to aid in the debugging and checkout of the IBM 1414 Channel and its control has been started.

(L. Huszar)

A routine to test and allow maintenance of the automatic ac-turnoff for the paper-tape punch on the console has been written.

(D. Chow)

Along with checkout of test programs for program interrupt, an Automatic Engineering Control routine has been prepared (in time for a demonstration during the AEC computer information meeting held here recently). This control routine, a forerunner of multi-programs, runs four existing test programs (BTC, DAD, DTC, EXT) in turn, allowing a quantum of five seconds for each test program.

During debugging of this routine, the following machine faults were discovered and traced:

1. The mask bits in SR2 were not being set correctly.
2. The clock mask was not being set correctly.

It appears furthermore, that if an interrupt flipflop is still on upon leaving interrupt on a JDCO, c, then control is <u>not</u> immediately transferred back to interrupt.

(M. Levin, G. Cooper)

Timing measurements were taken on the punch interrupt. Between execution of the SSRO, 0 instruction and the interrupt from the punch, approximately 7,520 CJS instructions can be obeyed.

(M. Levin)

PART II

ILLIAC II SYSTEM PROGRAMMING AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Systems Programming Summary

During the month PRINT-READ-PUNCH came into operation (with some errors). It and NICAP are operating within a simple-minded system under operator control. Effort is now being directed towards rewriting the assembler, I/O programs, etc., to improve their efficiency and to relate them to a Fortran/assembler operating system.

Programming and code checking is under way for the basic areas of the FORTRAN compiler.

(C. W. Gear)

2. Input/Output

A subroutine which handles transfers (without conversion) from ILLIAC to the 1401 and an input-output routine for temporary storage on the drum have been written and checked out. Both of these programs are temporary and do not take advantage of the interrupt facilities.

The interrupt programs are being modified for cards and code-checking will begin soon.

(Judith Aaron)

The TRACE routine has been translated into NICAP language. Check-out is continuing.

(Frank Schaffer)

Work has begun on the I/O facets of the FORTRAN compiler.

(J. Presti)

FORMAT INPUT/OUTPUT program has been checked out. Some modifications are presently being made.

(M. Gaer)

3. Library Subroutines

The GAUSS QUADRATURE subroutine has been converted to NICAP. An exponential subroutine is being checked out.

(Lorinne L. Lunde)

The subroutine COMPLEX ROOTS OF A POLYNOMIAL is being checked.

(T. Slivinski)

Work proceeds on the SINE-COSINE subroutine. At this point, the routine exists in modified machine language, and has been transferred to cards from paper tape. In addition, a test program to check the routine and to determine the maximum error by calculating $\sin 2x = 2 \sin x \cos x$ has been prepared. Timing of this subroutine is underway and a report on it will be written shortly.

(Roberta White)

The INVERSE LAPLACE TRANSFORM routine has been written in NICAP and will be checked.

A subroutine to handle outside FORTRAN labels which was written by Professor Pasta is being code checked presently.

(E. O. Brower)

4. ILLIAC I Simulator

The final subroutines and order routines for the simulator were written. However, code checking awaits an advanced version of the NICAP assembler since the present 1401 version cannot handle a program the size of the simulator.

(J. Bouknight)

5. ILLIAC II Operations

A. Log

1. Engineering		
General Engineering	200:43	
Drum Engineering	65:17	
1414 Engineering	137:49	
Systems Engineering	5:03	
Console Engineering	10:05	418:57
2. Engineering Tests		
ETR	1:52	
ASMD	1:20	
Memory Reversing	10:42	
DAMN	134:35	
BTC	10:53	
Exponent Test	2:57	162:19
3. Code Checking		88:58
4. Production		
Gillies	9:20	
Jordan	17:33	26:53
5. Demonstrations		:50
*6. Power Off		31:33
*7. Idle		14:30
TOTAL TIME		744:00

(W. L. Huffman)

* These two items occurred in the main on weekends when no one was in attendance.

B. Computer Errors

Reader	2
Punch	7
Core Parity	1
Flow Gating	1
Power Dumps	4
Unknown	4
Total Errors	22

(W. L. Huffman)

6. Component Failure Log Summary--October, 1963

Discrepancies

1. The number "20" did not get used.
2. No. 33, 2N711 is missing from the component box.
3. No. 46, 2N711 is missing from the component box.
4. No. 55, 1N961B, Zener is missing from the component box.

Components

Capacitors	2
Diodes	11
Zeners	4
Transistors	29
Total	46

Machine Stoppage

Components causing machine stoppage are indicated by use of an * in the tables. Fifteen components contributed to machine stoppage as follows:

Capacitors	2
Zeners	4
Transistors	9
Total	15

(C. E. Carter)

COMPONENT FAILURES FOR THE MONTH OCTOBER, 1963--SUMMARIZED NOVEMBER, 4. BY C. E. CARTER

COMPONENT	TYPE	LOG NO.	LOCATION	REASON	COMMENT
Capacitors	.1/30 v	*10	Q5R	Continued deterioration of poor components.	+25
	.1/75 v	*12	FG994#1-B7R	Continued deterioration of poor components	-50
Diodes	S577G or	34	T3R-133	Unknown	Open
	CDG950	35	T4R-129	Unknown	Open
		36	T4R-189	Unknown	Open
		37	T14F-138	Unknown	Open Found during collector
		38	S14R- 20	Unknown	Open bump checking.
		39	S11R-152	Unknown	Open Replaced in October.
		40	A14R-124	Unknown	Open
		41	S16F- 79	Unknown	Open
		42	S8F-157	Unknown	Open
		43	S8F-145	Caused by shorted Zener	
		44	S8F-165	Caused by shorted Zener	
Zeners	14.5Z5	*45	S8F-165-157	Unknown	Shorted
	1/4 M9.1Z5	*49	S10R- 47	Unknown	
	1N960	*53	CD15-261	Unknown	9.1Z ~ 2 v at .1 ma
	1N961B	*55	CE17-145	Unknown	Lost Voltage dynamically.

COMPONENT	TYPE	LOG NO.	LOCATION	REASON	COMMENT
Transistors	2N2080	*11	Console Tunnel	Unknown	short +25
	2N2081	*30	#1 Tunnel Reg.	Unknown	short +25
	2N1309	*13	CD18-94	Unknown	open
	2N967	*14	CE8-31		
	2N967	*15	CE8-115		
	2N967	16	CE9-125		
	2N967	31	CE9-125		Open due to a fault in CLEAR I.P.C.
	2N967	32	CE9-125		
	2N967	*50	A#7-81	Dynamically bad?	
	SM1530	17	DC4S-135	-25 v → -31 v	
		18	-141		
		19	-136		
		21	-142		
		22	-135		
		23	-141		Open in drum due to fault in power supply regulator.
		24	-136		Detailed reason is not understood
		25	-142		
		26	-135		
		27	-141		
		28	-136		
		29	-142		

COMPONENT FAILURES FOR THE MONTH OCTOBER, 1963--SUMMARIZED NOVEMBER, 4. BY C. E. CARTER (CON'T)

COMPONENT	TYPE	LOG NO.	LOCATION	REASON	COMMENT
Transistors (Con't)	2N711	*33	S3F#5 197	Unknown	$\alpha > 1$
	2N711	*46	S3F#5 81	Unknown	Sensitive--SHORTED
	2N335	47	REG. 5R Q105	Unknown	$\alpha < .9$
	2N445	48	Reg.6F Q302	Unknown	O/u--sometimes open
	2N1305	51	Punch R2C	Unknown	Short E-C
	2N2143	*52	+45 reg. core	Unknown	Driver--shorted
	2N241	54	Reg. 36, D5N	Unknown	Short b-c
	2N706	56	CE1 - 16	Unknown	Open b-e

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Henry Guckel has further investigated the optimum biasing points of Goto-pairs. He has also calculated the characteristic impedance of a more general strip line than that used heretofore. It is anticipated that this new strip line will allow greater flexibility in our coupling problems.

Louis van Biljon has studied the controlled production of microplasms and the first steps towards possible "microplasm logic" have been made. The study of the extinction condition for microplasms has been attacked theoretically.

Sergio Ribeiro and Gabor Ujhelyi have successfully coupled a lasing diode and a photoreceptor through the sides of a Dewar containing liquid nitrogen. For the moment, the high inefficiency of the laser and the photodiode make it necessary to use a very high-gain amplifier in the circuits. Steps are being taken to increase the efficiency of the light link.

2. Tunnel Diode Work

Investigation of the negative resistance region of the Goto-pairs has been continued and yielded the results shown in Fig. 1.

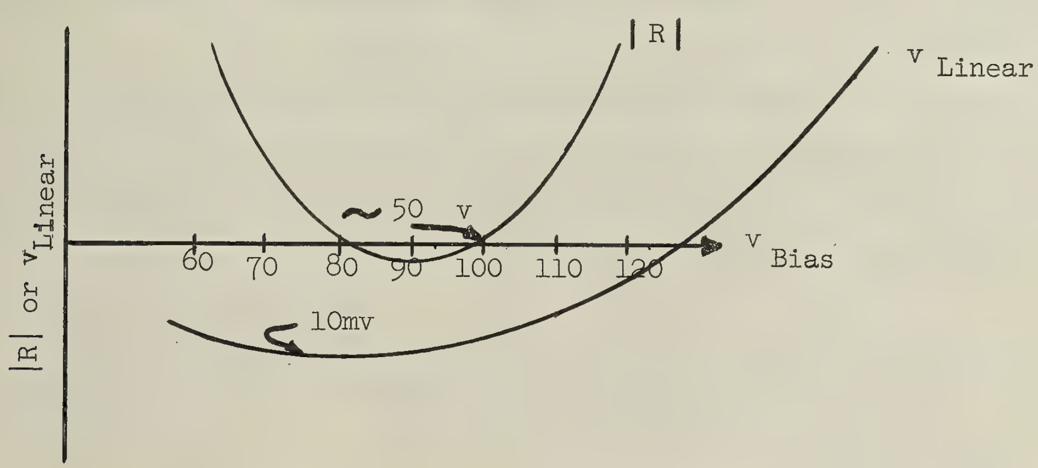


Figure 1. Linear Behavior of Goto-pair (1 ma Ge)

v_{linear} denotes the maximum voltage which may be applied in order to stay in the linear negative region. It appears that the negative resistance has a region of low sensitivity to bias voltage changes. This region does, however, not coincide with the region where v_{linear} reaches a reasonable value.

The results of this analysis applied to a "NOT" circuit of the π - type. The response was found to be faster than the rise time of the sampler. Calculated and measured gain agreed very well.

A generalized theory of coupled transmission lines was extended to include all known couplers as well as the amplifying structure described previously. The actively terminated line structure was extended to two asymmetric coupled pairs. The results are still incomplete, but do look very useful for high gain amplifiers. Results will be published in report form.

In order to interconnect the coupled line amplifier with a minimum of discontinuity, it was found desirable to have a special strip-line according to Fig. 2.

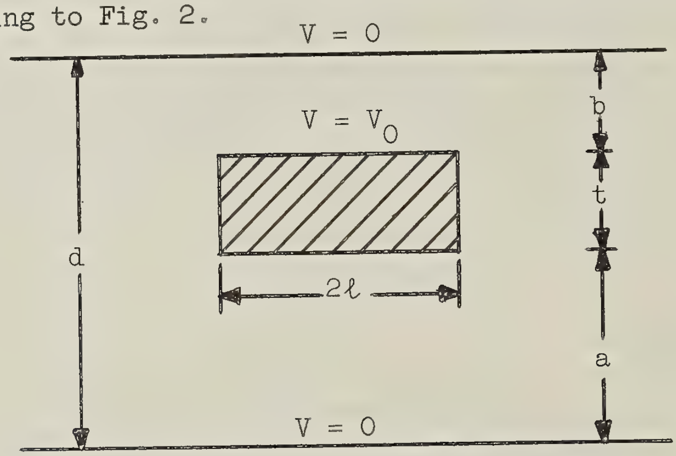


Figure 2. General Strip Line

A lower bound on the characteristic impedance was found by calculating the field energy of the structure shown in Fig. 2 and requires it to be stationary with respect to first order changes in a suitable specified trial function. This yielded:

$$Z_c = Z_o \frac{1}{\kappa\left(\frac{2\ell}{a} + \frac{2\ell}{b} + \frac{4a^2}{\pi^3 a^2} \sum_{n=1}^{\infty} \frac{1}{n^3} \left(\sin \frac{n\pi a}{d} + (-1)^{n+1} \frac{a}{b} \sin \frac{n\pi b}{d}\right)^2\right)}$$

Where

$$Z_o = \sqrt{\frac{\mu_o}{\epsilon_o}} \qquad \epsilon = \epsilon_o K$$

Calculations on the upper bound of Z_c via a Green's function approach are being attempted. It is intended to include the entire π-type "NOT" circuit in this structure and use it as a driving stage for the power amplifier.

The non-reciprocity relationships in ferrites have also been studied. Since these effects are closely related to interaction with circularly polarized fields, the generation of this type of field in a transmission line has been investigated. Partial loading with ferrite or dielectric will generate the necessary fields.

3. Avalanche Mode Work

A visit to some industrial laboratories has made it clear that accurate control of microplasma formation is possible. There thus seems to remain little doubt that the fast rise times associated with these localized breakdowns may profitably be employed in fast circuits

For good microplasma control however, very well fabricated junctions are required; better than any junctions encountered in transistors during the present investigation. Conventional transistors leave depletion regions where, if microplasma type breakdown is present, too many small breakdowns are present separated by too small a voltage between their specific breakdowns. Also, the mutual interaction in a many-microplasma junction makes isolation of a single well defined breakdown impossible. Dr. Haitz of the Shockley Laboratory of Clevite has undertaken to supply us with suitable junctions; these are now awaited.

The most suitable way for initiating the breakdown seems by photon injection and apparatus is now being constructed to provide suitable light pulses. A short arc, high pressure mercury lamp has been ordered to serve as the source.

On the theoretical side, several models of microplasma formation are being analyzed. The aim is to try and explain what the factors are which determine the extinguishing of the discharge. The initiation of the discharge seems relatively clear, but the random manner in which the arc disappears still poses problems. The trapping model of Shockley and the chance variation of carriers proposed by Rose and by McIntyre do not seem entirely adequate. Considering the high volume density of beat dissipation in and near a microplasma, it is felt that the temperature may play an important role.

The model proposed now requires that a certain minimum field strength be present in the junction, but this minimum required field is a function of the lattice temperature. At higher temperature, less field will be required due to decreased thermal losses by electrons to the lattice.

Complications arise however, as at higher temperatures the carrier mean free path is reduced and thus decreases the influence of the electric field. Simplifications are introduced to partly linearize the interactions and it is hoped that an expression will be found for the length of microplasma pulses to be expected from a junction.

Analysis also shows that due to the small size of the breakdown region, the capacitive effects associated with them will be small. With a space charge resistance (according to the Shockley theory) of about 10 KΩ and a capacitance of a fraction of a picofarad, it is not expected that these pulses will be limited by junction R-C time considerations. With the fields required for microplasma formation, carrier transit time is of the order of 1 picosecond and this time will set the ultimate limit to junction response.

4. Photocoupled Circuits

The major barrier for fast photocoupled circuits at the present is the lack of a low threshold current laser diode. Laser diodes reported in the literature produce coherent light generally above 1 ampere current input. (Although the coherence of light is not necessary for the coupling mechanism, laser diodes exhibit sufficiently high efficiency only in the coherent mode of operation.) Because of the very high current levels the laser diodes must dissipate over 1 watt of power in the coherent mode; this and other factors require intensive cooling, typically in liquid

nitrogen at $77^{\circ}K$. To reduce the threshold current to about 100 ma, the junction area must be reduced from 10^{-3} cm^2 to about 10^{-4} cm^2 for a Ga As diode, which seems to be very difficult from the technological point of view. The recently reported silicon carbide laser diodes, which operate at room temperature, in the visible region and at much lower current density appear to be the solutions for the above mentioned problems, but these units are not available commercially as yet. The currently available fast photodiodes have very small effective areas and therefore an optical focusing system must be used for the coupling.

It was found that our Ga As photoemissive diodes have very low efficiency in the 0 to 100 ma current range and that the tunnel diode amplifier designed previously does not have sufficient gain to overcome the losses in the coupling. A fast, two stage transistor circuit was designed and tested providing a current gain of up to 10,000. An experiment (see Fig. 3 and Fig. 4) was carried out to test the coupling by placing a Ga As diode into a Dewar bottle containing liquid nitrogen, and the suitably oriented photodiode and the transistor amplifier on the outside of the Dewar. With 70 ma current pulses driving the Ga As emitter diode the output from the transistor amplifier was only 1.5 ma. An improved version of this experiment is under construction.

A Philco GAE 404 Ga As infrared source was received and tested at room temperature; for 80 ma current flowing into the GAE 404, we had 10 μa current generated in the S.D.100 photodiode placed close by. (The efficiency of this coupling is therefore 0.0125%.)

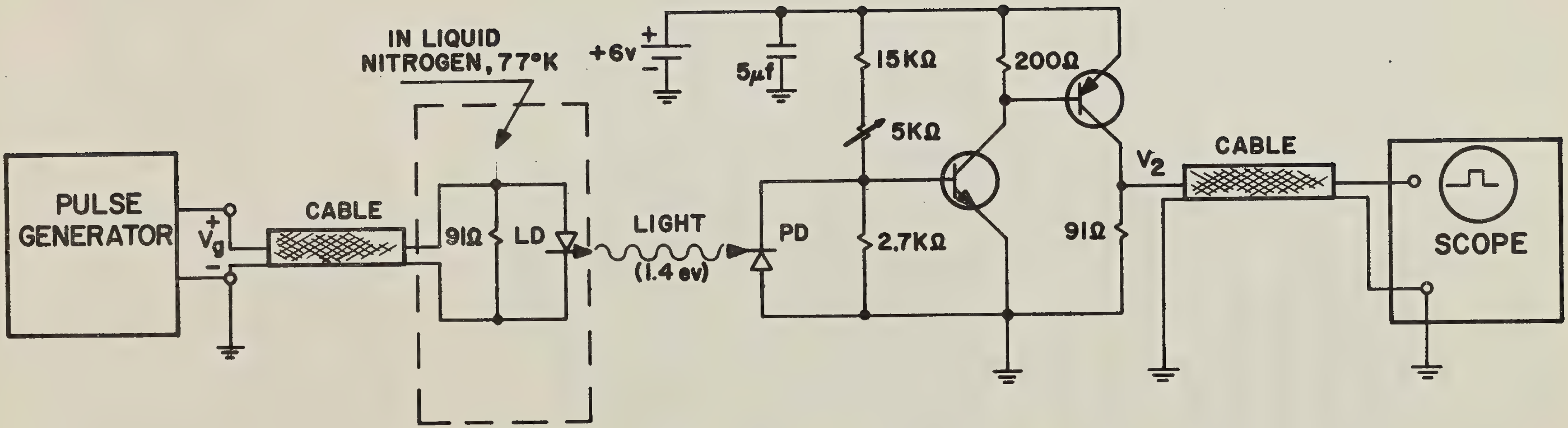


FIG. 3 CIRCUIT DIAGRAM FOR THE LASER EXPERIMENT

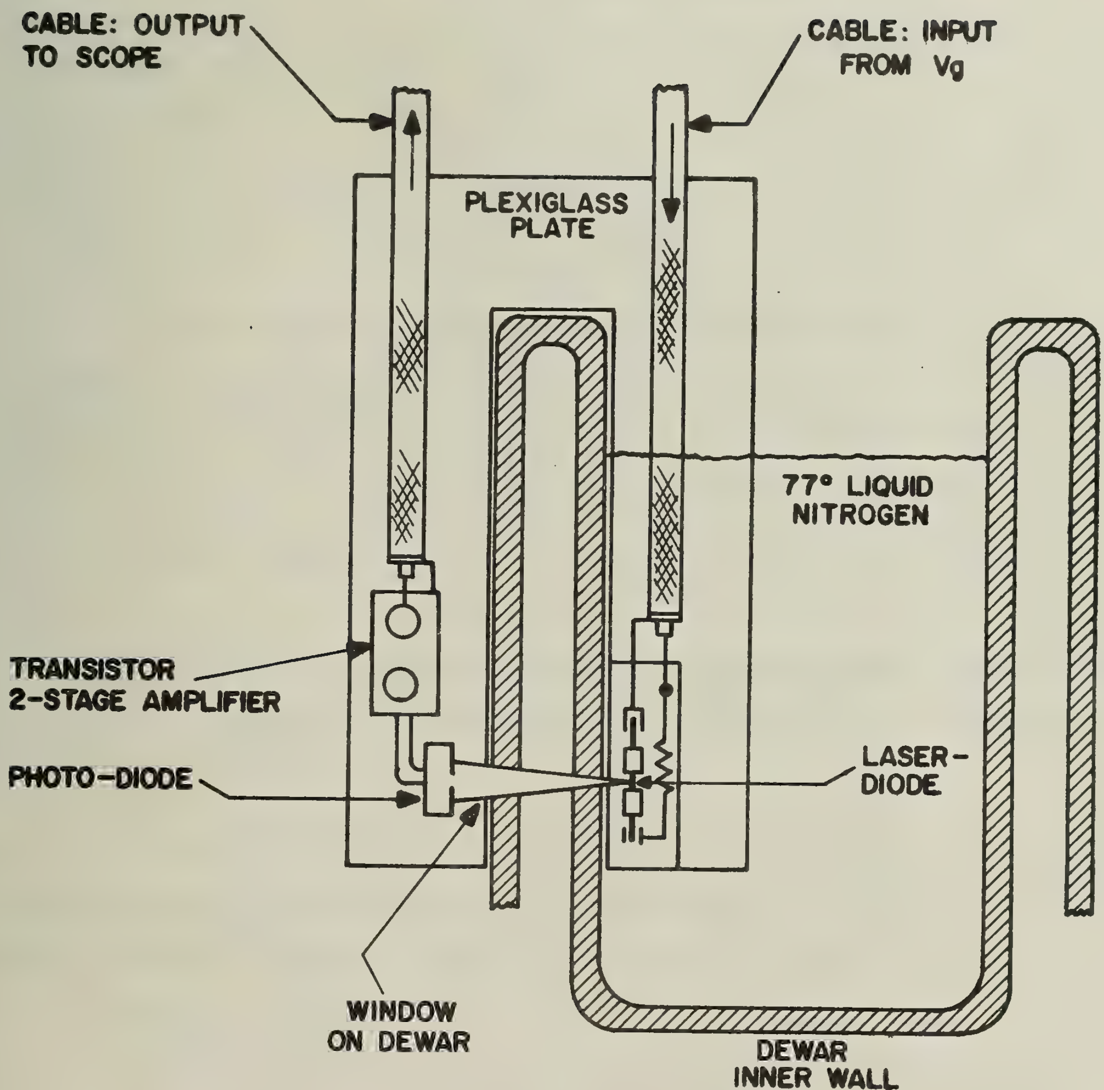


FIG. 4 LAYOUT OF THE LASER EXPERIMENT

PART IV

IBM 7094-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

NEW ROUTINES

B1-UØI-SIN3-47-SR Double Precision Floating Point Sine and Cosine SCATRE, SCAT, FØRTRAN, and MAD. This program computes the double precision floating point sine or cosine of a double precision floating point argument in radians. If the exponent of x (the argument in radians) is larger than or equal to 50_{10} an error message will be printed. This routine will accept an unnormalized argument. However, if the exponent is larger than one and the argument badly unnormalized, there will be a significant loss of relative accuracy.

The argument must be stored according to IBM 7094 mode, i.e. the more significant part in an even core location 2n; the less significant part in odd core location, 2n+1.

(David Hutchinson)

M2-UØI-CNV2-48-SR Convert BCD Characters to a Double Precision Floating Point Number SCATRE, SCAT, FØRTRAN, and MAD. This routine will read a string of characters representing the digits of the fractional and exponential parts of a floating point number from one set of memory locations, convert it to double precision floating point form, and store these in two memory locations in normal 7094 double precision form.

(David Hutchinson)

During the month of October, 56 problem specifications were submitted to the IBM 7094.

581-39056 Chemistry and Chemical Engineering. Kinetics of Displacement Reaction. In connection with the analysis of kinetic data, it has become necessary to apply simple statistical regression techniques.

Standard formulas for the calculation of a straight line are used. The regression line is calculated assuming errors in x<<y.

The input consists of the coordinates of the points (x, y) forming the line, along with the number of points and their relative weight. The data received is the intercept of the regression line, its standard deviation, the slope of the line and its standard deviation, and the standard deviation(s) of the points from the line along the y axis.

582-39057 Chemistry and Chemical Engineering. Molecular Configurations. In this research previously developed computational techniques will be used to compute the ratio of successful walks to total walks at each equivalent point in a tetrahedral lattice. The IBM 7094 will be used to generate sample walks by Monte Carlo techniques. Then, at each additional step, the walk will be tested for loops. The "end-to-end" distances and other information for each walk at each step will be stored in a table until completion of each run. It is estimated that approximately 250,000 walks will be needed to obtain sufficiently reliable statistical data for each equivalent point in a tetrahedral lattice with a maximum of use.

583-39058 Psychology. Personality Dimensions in Children. The purpose of the present long-range study is to isolate the principle dimensions of personality in children. The magnitude of subjects and variables included in the investigation requires the capacity and speed of the IBM 7094.

The following standard library programs will be employed: correlation program for generating $\underline{m}$ x $\underline{m}$ matrices of relationships, the principle axis factor analytic procedure, the iterative communality program, and available rotation programs.

584-39059 Civil Engineering. Inelastic Behavior of Framed Structures. This problem concerns the analysis of the behavior of multi-degree of freedom systems in the elastic and inelastic range when subjected to time-dependent dynamic or earthquake loadings. The purpose is to study the permissible approximations that may be made when idealizing framed structures so that the behavior obtained will be in good agreement with the behavior obtained from more exact and lengthy analyses.

The dynamic equilibrium of a frame, loaded into the inelastic range, is given by a set of coupled, non-linear differential equations. These equations are solved by a step-by-step procedure in which the structure is assumed to behave linearly within a small increment of time so that the nonlinear response may be given by the sum of a series of linear analyses. Within the time interval, the changes in inertia forces, damping forces and elastic forces must be equal to the change in external loads.

Assuming the acceleration to vary linearly within each small time increment, corresponding changes in velocity and displacement are calculated so that total displacements, velocities and accelerations for each mass can be computed.

Output data for this problem include variation and maximum values of displacements for the various lumped masses, of shear, bending moment and inelastic action developed throughout the structure.

585-39060 State Water Survey. Reservoir Storage and Silt Determination. A method to determine the Reservoir storage capacity and silt volume of various reservoirs in the state of Illinois will be exploited.

The mathematical model is: $V = V_1 + V_2 + V_3 = A'/3\ (E_1 + E_2)/\ (W_1 + W_2)$

$+ A/3\ (E_1/W_1 + E_2/W_2) + h_3E_3/130{,}680$ where: $A =$ segment surface area (acres), $E_i =$ cross-sectional area (ft.^{2}), $W_i =$ range-width (ft), $h_i =$ perpendicular height of quadrilateral area (ft).

586-39062 Psychology. Selection of Objective Personality Tests with Children. This study will involve the intercorrelation of about 80 variables for 300 children, then a principle axis determination of the number of factors. A factor analysis with machine rotations (Oblimax) will then be carried out. After visual finalizing of axis, several attached studies linking items from within tests to the main factors identified will be carried out using the intercorrelation program.

587-39064 Psychology. Power of Nonparametric Tests. Monte Carlo methods will be used to determine the empirical power of certain statistical tests for small sample sizes. The population distributions to be sampled are from the normal, rectangular (uniform), and exponential (e^{-x}). The statistical tests to be considered are those for matched pairs and are the t-test (student's test), the sign test, the Wilcoxen one-sample test, the Walsh test, and The Fisher-Pitman randomization test.

588-3Ø001 Aeronautical and Astronautical Engineering. Accelerating Cone. The machine will be used simply to evaluate some rather complicated algebraic expressions over a wide range of values.

589-3Ø002 Economics. Spectral Decomposition. The research problem consists of testing the Markov chain within general contingency analysis, using a likelihood ratio test, essentially a ratio between terms such as: $\sum\sum\sum m_{ijt}{}^{m_{ijt}}$, where m_{ijt} is a sufficient statistic for the parameter P_{ijt} in a Markov transition matrix. Once the test is applied, a spectral decomposition of the hypothesized Markov process is performed, a steady state solution obtained, and equilibrium vectors for any number of time periods for the future are calculated.

590-3Ø006 Psychology. Development of Personality Factors. This research is a factor analytic study of personality development. The method to be used is principal axis factor analysis, and several special matrix operations.

591-3Ø007 Psychology. Temporal Parameters of Behavior. Temporal measurements of psychological, psychomotor and physiological activities will be correlated. This will give a 47 X 47 matrix which will be factor analyzed using the principal axis method. The factor matrix will be rotated using both varimax and oblimax routines. Additional graphical rotations will also be taken. Second order analysis will be performed on the oblique factor matrix. Certain variables of interest will be analyzed in relation to other variables which tend to cluster in the same factor. This will involve transformation of scales and multiple regression.

592-3Ø008 Mechanical Engineering. Hypersonic Nozzle Area Functions. This research problem involves the calculation of hypersonic nozzle areas as a function of the axial distance along the nozzle. Approximately ten different equations will be used to determine nozzle shapes. These nozzle shapes will then be used in another research problem that calculates the effect of vibrational non-equilibrium on test section stream properties for a low density hypervelocity wind tunnel.

593-3∅011 Education. Form Reproduction I. The general research goal is the construction, standardization, and description of usability of a series of geometric forms to be reproduced by children with paper and pencil. The 7094 will be used in the evaluation of alternative scoring methods and of indices of test validity. Correlation and standard descriptive statistics will be required for these purposes.

594-3∅012 Chemistry and Chemical Engineering. Kinetic Data Analysis. The problem under consideration is the analysis of effects of porous catalysts on stirred-reactor kinetics. Data obtained from laboratory reactors are to be used to fit reaction parameters (rate constants, activation energies, etc.) to rate equations for the system.

The 7094 will be used to perform an "iterative" least squares reduction of the data to fit given forms of the rate equation so that "best" values of the reaction parameters and of the rate equations may be found.

Standard library subroutines will be used.

595-3∅013 Agricultural Engineering. Loads on Two Hinged Arches. The program will be used to analyze commonly used two hinged timber arches subjected to combinations of wind, snow, and grain loads. From the analysis it is hoped that recommendations can be made on the manner of bracing or fabrication such that these timber frames can be used for grain storage.

596-3∅014 Home Economics. Expenditure Relationships. Each year about 115 farm families send in account books to the University for summarization and analysis. These books contain a daily record of family living expenditures plus annual income, annual farm expenses and other information about the families.

F-ratios have been determined for total family living expenditures as well as for each major category of expenditures such as food, clothing, housing, recreation, etcetera, in terms of annual gross income, number of years of marriage, and number of persons in the family. Significant F-ratios were found for many of the expenditure categories.

In order to determine more accurately the relative importance of each variable on family living expenditures, and the extent of intercorrelations among the variables, it is proposed to obtain Beta coefficients and T-statistics for the three characteristics mentioned above plus the wife's education, wife's age and disposable income.

597-3Ø015 Agricultural Economics. Quadratic Programming. The project consists of the development of a routine for the quadratic solution of spatial equilibrium problems. The program will involve a modification of the simplex method of non-linear quadratic programming.

598-3Ø016 Aeronautical and Astronautical Engineering. Randomly Crooked Columns. The general problem to be undertaken in this thesis is to determine the effect of initial random crookedness on the deflection of an Euler Column. The solution involves a series approximation which must be evaluated for various parameters.

599-3Ø017 Electrical Engineering. Calculation of Scattered Light Intensity. When light is incident in a gas medium, it is scattered by the gas molecules. The intensity distribution of the scattered light is proportional to

$$I(x) = \frac{\lambda}{\sin\frac{x}{2}} \int_0^\infty P(r) \sin\left[\frac{4\pi r}{\lambda} \sin\frac{x}{2}\right] r\,dr$$

where λ is the wavelength of the incident light, x is the scattering angle, and $P(r)$ is a function which is not explicitly known. $I(x)$ can be evaluated for a set of assumed functions $P(r)$ and can be compared with the experimental values. This procedure yields information with regards to the functional dependence of $P(r)$ upon the parameter r.

600-3Ø018 Chemistry and Chemical Engineering. Boiling on a Fin. The equation to be solved is

$$\frac{d^2\Theta}{d\,x^2} = C\,\Theta$$

where C is an empirically determined function of Θ. Standard library subroutines will be used to evaluate C by interpolation and to solve the differential equation. The equation above describes the temperature distribution in a fin when the heat transfer coefficient is a function of temperature.

601-3Ø019 Agricultural Engineering. Centrifugal Pendulum. This problem involves the solution of the differential equations that describe the dynamic characteristics of a centrifugal pendulum. In this problem the pendulum is used as a flail knife for turf maintenance. It is desired to use the computer as an aid in pendulum design.

602-3Ø020 Educational Testing. Test Bias in Measuring Achievement. In educational research it is sometimes found or claimed that certain item types, such as true-false items or essay items, give an artificial and undesired bias to certain persons or to persons taught by certain methods. Evidence of such bias is not possible by analysis of variance techniques because the tests embodying different item types do not yield comparable scores. The problem can be dealt with by factor analytic procedures, it is believed, because a constant error for a portion of the examinees, if operating with several variables, should itself define a factor. In this research artificial data will be generated with the hypothetical bias built in; and this, with real data, will be analyzed to find out the sensitivity of this method to the presence of item bias in achievement testing.

The 7094 will be used for correlation matrices, factoring and rotations, and perhaps for other matrix operations and for regression analyses if needed.

603-3Ø021 Physics. Interstitial Diffusion. Several diffusion problems have arisen in connection with an experiment which measures the diffusion constant for single interstitial atoms in a metal lattice. To obtain a comparison of experiment and theory it is necessary to have numerical solutions to some of these problems. The cases of the diffusion equation which are of interest have been solved using Laplace transform method. The computer will be used to evaluate these series solutions to an accuracy of about 1% for various values of the important constants. The series converge very quickly ($\leq$ 10 terms in almost all cases) and can be evaluated with great ease using the computer.

604-3Ø022 Psychology. Parent Child Relations. This investigation is concerned with a questionnaire attempt to identify salient parent-child relations which lead to pathological personality development in children, as well as to help formulate a theory of child personality development based on empirical relationships. The 7094 will be utilized to aid in construction of the basic questionnaire, scoring of obtained data, and testing of formulated hypotheses. Correlational and multivariate techniques will be the basic analytic procedures used; however several special programs have been written to aid in data analysis (i.e. scoring programs, response frequency programs, and transformation programs.)

605-3Ø026 Finance. Regression. The problem involves multiple regression of economic time series. Briefly, the relationship to be explored is a lagged relation between reserve capacity of the banking system and the demand deposit componen of the money supply.

606-3Ø027 Theoretical and Applied Mechanics. Elasticity. The research problem concerns the determination of stresses and strains in a notched half-plane which is loaded by certain isolated forces at points inside the semi-infinite body.

The final step in the problem is to solve an infinite system of linear equations. Since only the first unknown is of interest and it is impossible to solve an infinite number of equations it was decided to use computer programming to solve a series of n linear equations with n unknowns with n ranging from 5,7---. until the numerical answers obtained for the first unknown converges toward a definite value.

607-3Ø028 Civil Engineering. Moment-Load-Curvature Relation. The program will determine the relation existing between moment, load, and curvature for a hollow rectangular cross section made of a bilinear material.

By selecting a position of zero strain and a curvature, the load and moment can be found by integrating a stress function over the area of the cross section. Owing to the nature of the stress-strain curve and the complex boundry conditions, a numerical form of integration is practical. The IBM 7094 is used to perform the detailed, repetitive computations.

608-3Ø029 Institute of Government and Public Affairs. Determinants of Public Assistance Expenditure. The problem is to analyze the trends in public assistance expenditure in the United States. Multiple correlation analysis will be applied to both cross-section and time-series data to determine the relationship between various social, economic and political characteristics and public assistance recipient rates and average payments to recipients.

609-3Ø030 Biophysics. Permotron Simulation. This problem will determine where and how much within a large net of artificial neurons (called a Permotron) the permanent memory variables are changing when sequences of input states which are non-random are presented to the net. It was previously found in simulating the Permotron that random input sequences did not cause much permanent memory change beyond the first neuronal relays in the net. Thus it was found that the net was capable of not wasting its memory capacity on random inputs, an unsuspected result.

610-3∅031 Mathematics. Normal Probability Table. It is desired to devise an algorithm such that the user may enter the routine with a "Z" score ($0 \leq Z \leq \infty$) and the machine will return the area under the normal probability distribution. The defining equation of the normal probability distribution is

$$A = \frac{1}{2\pi} \int_{0}^{Z} e^{-t^2/2} dt \text{ where } 0 \leq Z \leq \infty \text{, and}$$

where A is area and Z is the Z score in question.

This routine, it is believed, would be of great use in statistical programs where hypothesis testing takes place.

611-3∅033 Agricultural Economics. Chicago Milk Supply. The problem is one of analyzing production adjustments of the agricultural sector with emphasis on the level of milk supplies available at various alternative prices for milk and competing production activites. The production area being studied, the Chicago Milkshed, is divided into six regions to achieve greater homogeneity of production conditions. Given the types and quantities of regional resources, transportation costs for moving commodities between regions, and the production alternatives, the model is then used to estimate production levels for milk and competing commodities and to show optimum milk movements between production regions.

The LP/90 computing system for linear programming will be used to solve the mathematical model.

612-3∅035 Office of Instructional Research. Graduate Record Study. The intent of this study is to identify possible predictor variables of graduate achievement. The variables to be analyzed will consist of test scores, previous grades, undergraduate data, performance in certain "marker" courses, and instructor ratings. The 7094 will be used for the statistical analysis of this data. The analysis will include inter-correlations, multiple correlations, and analysis of regression. Standard programs, which will include the Statpac and UCLA's BIMD series, will be used wherever possible. A separate analysis will be carried out for each department; thus the exact procedure to be followed will vary from department to department. The results will be printed in a form suitable for direct reproduction.

613-3∅036 Civil Engineering. Competitive Bid Strategies. The problem will be concerned with competitive bid strategies for contractors in the construction industry. It will enable a contractor, by using his past cost and bid data and the bid data of his competitors, to improve his chances of winning (being the lowest bidder) a prospective job by being more selective in what jobs the contractor bids and how he bids those jobs he has selected.

The IBM 7094 will be used in the solution of this problem since first a program will be constructed from the mathematical model, which combines the normal and Poisson distributions. Next real data will be submitted with the program to the computer to test the validity of the model. If the data does not fit the model, the model will be altered, if feasible, and the altered model tested. This process will be repeated until such time as the data and a model agree or no models agree with the data.

614-3Ø037 Civil Engineering. In Place Strength Determination. The problem is essentially a multiple regression correlation analysis.

615-3Ø038 Physics. Restricted 3-Body Problem. The work involves the numerical integration of two coupled, non-linear, second-order (total) differential equations; a first integral is known and used in the calculations. In brief, the equations of motion are:

$$\ddot{E} = f\,(E,F)\,\dot{F} + \frac{\partial H}{\partial E}\,(E,F); \quad \ddot{F} = -\,f\,(E,F) + \frac{\partial H}{\partial F}\,(E,F)$$

where $2H = \frac{1}{8}\,(\cosh 4F - \cos 4E) - \frac{T}{2}\,(\overbrace{\cosh 2F - \cos 2E}^{f}) + 16 \cosh F + (\gamma/2) \times$

$(\cos E \cosh 3F - \cos 3E \cosh F - 32 \cos E) = \dot{E}^2 + \dot{F}^2$

The latter relation is the first integral; γ and T are parameters which are varied.

The Runge-Kutta method is used for integration (variable interval control has been found unnecessary). Briefly, initial conditions are specified and then varied systematically until specified final boundary conditions are met. Then T is varied to trace out a <u>class</u> of periodic solutions, and finally γ (the mass ratio), to see how the classes change. The machine will do most of the analysis and turn out classes of (usually symmetric) solutions - main results only.

616-3Ø039 Psychology. Monte Carlo Data for Factor Analysis. An investigation is being made in order to discover procedures for developing matrices of intercorrelations possessing some given structures in the variables and some random elements in the variables such that these correlation matrices will possess properties, when factor analysis is applied, which more nearly parallels the properties of correlation matrices obtained with real data than do concocted matrices using existing procedures and models The procedure will be mechanized so as to produce a number of examples for study. One hope is to obtain material for critical study of the effectiveness of various methods of factor analysis.

617-3Ø040 Psychology. Motivation Measurement. The problem involves the definition and measurement of major dimensions of human motivation. The measurement involves the use of a variety of techniques to arrive at estimates of various aspects of motivation strength. These are combined to provide a multivariate analysis of behavior by direction and quality of motivation.

618-3Ø041 Veterinary Pathology and Hygiene. Spacing of Skunks. This problem involves measuring the effect of spacing of skunks on the nidality of leptospirosis. Spacing has been measured by the size of individual ranges and the amount of overlap between ranges.

619-3Ø042 Men's Residence Hall Association. Residence Halls Turnover. The problem concerns investigation of variable characteristics of political units in the Men's Residence Halls and the relationship between these characteristics and resident turnover. One computer problem is to calculate correlation coefficients and multiple correlations among the variables. A second problem is the testing of questionnaire subtopics by their relationship with the mean topic score.

620-3Ø043 Physics. Orbit Plotting. A new laboratory experiment in Physics 106, is being developed. This consists in having the students integrate an orbit by graphical means. The students are given the starting constants, and then in a graphical iteration sequence the orbit for various laws of force is stepped out. The purpose of this 7094 program is to determine the stable range of solutions of the difference equations.

621-3Ø044 Economics. Simulation of U. S. Economy. This research project entails building aggregate growth models of the United States economy. Estimates of the equations of the model will be obtained by appropriate statistical techniques--least squares, two-step least squares, limited information estimates, and maximum likelihood. Simulated runs will be made to test alternative government policy measures see their effect on the growth of the economy.

622-3Ø046 Chemistry and Chemical Engineering. Development of Structure Factor. The Structure Factor is a calculated value of theoretical intensities and phases of diffracted X-ray beams. The general form of the Structure Factor is:

$$F_{bkl} = \sum_j f_j \exp\left\{ i2\pi(bx_j + ky_j + lz_j) \right\}$$

where f_j is the scattering factor of the j th atom, b,k,l are the Miller indices of the reflecting planes, and x_j, y_j, z_j are the spatial coordinates of the j th atom.

The purpose of this program is to develop working structure factor programs for specific crystal space groups, which will be of aid in the determinations of three-dimensional molecular structures.

623-30047 Agricultural Education. Job Title Clusters. The problem is to determine whether job titles hang or cluster together in terms of activities involved in jobs. The method proposed to obtain information regarding this problem is to calculate phi correlations for job titles plus activities matrix, then to carry out a factor analysis with oblique rotation.

The size of the sample is 511. One hundred and fourteen variables are being analyzed.

624-30048 Digital Computer Laboratory. Numerical Analysis, Parabolic Equations. Recent developments have pointed toward some parabolic difference equations with very high order error terms. The purpose of the present study is to compare solutions of such approximations with the exact solutions of the heat equation, thereby determining the amount of work necessary to obtain a certain precision in the difference approximation.

625-30049 Children's Research Center. Personality in Delinquency. This research seeks to determine the dimensions of personality associated with juvenile delinquency. The method involves the correlational and factorial analysis of questionnaire responses, behavior ratings and case record analyses; determining the interrelationships among factor scores, and finding the correlates of these factor dimensions with other variables.

The rotation of factors will be based on minimum loading.

626-30050 Institute of Communications Research. Assessment of Peace Corps Volunteers. The attitudes and feelings of Peace Corps volunteers should be important determinants of their effectiveness. To test this hypothesis, volunteers were asked to rate concepts pertinent to modern history (such as U. S. foreign policy, Other Nations, etc.) on a number of Semantic Differential scales. The information gathered in this way will be examined to see if attitudes on these concepts are capable of predicting effectiveness of the volunteer.

In addition, the same information was obtained from other groups of subjects: a group of graduate students, and several groups being sent abroad under other auspices, such as missionaries. Analyses will be performed to determine if there are significant differences between the various groups as measured by the Semantic Differential.

The main forms of analysis to be used are correlations, principal axes factor analysis, factor scores, and multiple discriminant functions.

627-3Ø051 Institute of Communications Research. Validity of the Personality Differential. This is an attempt to validate a form of the Semantic Differential especially developed to discriminate among various personalities. Subjects will be asked to rate a number of personalities using the Personality Differential, and will be asked to perform other tasks as well which should reflect the way in which the subject actually perceives various personalities in his world.

The analysis will assume a "person perception space", which is Euclidean. The dimensionality of the space and location of the personality concepts in the space will be examined by means of factor analytic techniques. Results of this analysis will be compared with other measures of perception of personalities by means of discriminant function analysis.

628-3Ø052 Civil Engineering. Analysis and Behavior of Slab-and-girder Bridges. The problem under study is the analysis and behavior of right Slab-and-girder Bridges, simply supported at the ends, with and without diaphragms, taking into account the flexure, torsion and the warping of the structural elements.

The method of analysis consists of a combination of Rayleigh-Ritz energy procedure and Levy type of analysis for rectangular plates simply supported on two opposite edges. The most important variables, among others, proposed for the study are: the relative stiffness of the slab and the girder, the relative stiffness of the diaphragm and the main girder, the number and locations of the diaphragms, the ratio of spacing of the main girders to the span of the bridge, the effects of torsion and warping of the girders on the moments in slab and the girders and, the number and location of loads applied on the bridge. The study will determine the design moments which are significant for a particular girder.

629-3Ø053 Agricultural Economics. Supply Curve Computation. This supply curve computation requires weighted lateral addition of marginal cost curves specific to representative firms. The marginal cost curves are derived from a technological production surface and from price data.

630-3Ø055 Electrical Engineering. Active Filter. A method of active filter synthesis is to be studied. In the study one develops m non-linear algebraic equations with $n>m$ unknowns. It is proposed that the solution of the m equations be studied as a function of n-m parameters and then results of this study applied to the increased understanding of active filter synthesis.

It is anticipated that the solutions to the m equations will be found using a Newton-Raphson method in m dimensions.

The numbers m and n depend on the topology of the filter and satisfy $m \leq \frac{2}{3} n \leq 20$.

631-3Ø056 Mechanical Engineering. ASHRAE RP-16. This research work is concerned with developing a theoretical model for the determination of air flow patterns at return intakes. Several models have been proposed and it is necessary to determine the best model and then modify it so that the best possible analytical results may be obtained. A large number of repetitive calculations are involved which require no analytical methods other than the standard library routines.

632-3Ø057 Physics. Experimental Calculations. The computer will be used to perform the calculations on experiments relating to the extremely precise measurement of electrical field and circuit parameters.

The mathematical methods employed will be standard methods for the solution of systems of linear equations, approximations, solutions of non-linear equations, and some statistical error analysis.

633-3Ø058 Electrical Engineering. Language Analysis. The rank-frequency relationship of word occurrences in various natural language corpi produced under constraints of several types will be studied. The major tool will be a routine recently developed which accepts natural language corpi from punched cards, compiles a vocabulary organized according to both word-length and initial letter and outputs a record of the input sequence displaying the vocabulary parameters and a serial number for each word from which the entire material may be recovered if desired. Detailed provisions are included for handling numerical or algebraic inputs.

634-3Ø059 Digital Computer Laboratory. Stellar Stability. The set of equations for a static, isentropic, radially symmetric, general relativistic gas are to be integrated. The integration is carried from the origin to the edge of the gas, which point is determined by the density and pressure reaching zero. The total mass, total energy, and resultant radius are thus determined as functions of central temperature. The stability of the star as a function of central temperature is to be sought and studied.

635-3Ø060 Education. Automatic scoring of Schematesizing Test. The scoring of the Schematesizing Test involves a large number of arithmetic and logical operations that are far too time consuming for manual scoring. This test is being developed as a means of predicting academic success in elementary school children.

636-3Ø061 Civil Engineering. Best Hyperbolic Sine Curve. A computer program has been set up to reduce data obtained from direct shear testing of thin film bituminous materials in a parellel plate microviscometer. The data obtained from testing consists of the shear stress, τ, and the shear rate, $\dot{\gamma}$. Evaluation of the constants A and B in the equation $\dot{\gamma} = A \sinh B\tau$ is to be done by the computer in an iteration process utilizing the method of least squares and the fact that the second derivative of the above equation allows the constant B to be determined independently of the constant A.

The output data consists of, the input data, the values of A and B, and the coordinates of several points lying on the "best-fit" hyperbolic sine curve passing through the original input data.

During the month of October, 12 instructional problem specifications were submitted to the IBM 7094.

I82-39061 Mechanical Engineering 260. Performance of a Cooling Tower. The problem is to predict the performance of a cross-flow cooling tower by dividing the tower into a number of small sections for which arithmetic-mean differences are applicable.

I83-39063 Civil Engineering 391. Problem 1. Traverse Closure. This problem is designed to familiarize students with the DCL system. The traverse closure problem discussed in class is used as an example. By simple geometric relations and logical decisions, the sums of x and y components of an arbitrary number of line segments are obtained. A complete deck, including control cards, source program, and data is supplied, and the student has only to punch his ID card. The output is used to discuss the details of the PØRTHØS system.

I84-3Ø003 Civil Engineering 391. Problem 1. Traverse Closure. The problem involves the summing of unbalanced latitudes and departures for a traverse and computing the error in closure.

I85-3Ø004 Electrical Engineering 330. Transformer Equivalent Circuits. In connection with a part of the problem it will be necessary to use a Fourier series analysis to find the first 9 harmonics of the transformer exciting current. If a routine for evaluating the coefficients is available it will be used.

I86-3Ø005 Civil Engineering 391 Problem 2. Maximum Moments. Write a program to compute a curve of maximum moments for a simple beam of span L, produced by a standard AASHO H or H-S truck load. Note that the third axle, P_3, may or may not be present, and that the truck can face in either direction. The curve of maximum moments is to be generated by subdividing the span into n equal lengths, and evaluating the maximum moment at the points $x_i = \frac{i}{n} L$, $i = 1,2,\ldots\frac{n}{2}$, (i.e., up to midspan).

Note that for each point x_i, the following conditions may exist:

a) only one axle fits on the span

b) one additional axle fits on right, no axle fits on left

  b1) if H-S loading, use P_2 and P_3

  b2) if H loading, use P_2 and P_1

c) one axle fits both on right and left

d) two axles fit on right, no axle fits on left

e) two axles fit on right, one axle fits on left

f) two axles fit both on right and left

Possibilities c through f may have to be further subdivided depending on whether and H or H-S loading is used

The program is to start as follows:

```
1 READ INPUT TAPE 7, 2, SPAN, MPANS, P1, P2, P3, WBSE
```

(SPAN and WBSE in feet; P1, P2, P3 in kips)

Output is to consist of three quantities for each value of i, as follows:

i

x_i in feet

M_i in foot-kips

I87-I89 - 3Ø024-3Ø023 Industrial Engineering 283 and 237. Problem 1. Location of a new item in an Existing Facility. It is often desired to locate a new machine in an existing facility. This routine evaluates the material handling cost of each location within the factory. The resulting cost at each point is printed. When a "contour map" of the cost has been made, the new machine can be optimally located.

I88-3Ø025 Industrial Engineering 283. Problem 2. Linear Programming. Each student makes up a linear programming problem of his own. He then key punches his data deck and submits it together with the linear programming routine (cards furnished by the instructor). The purpose is to introduce the student to the availability of library routines and the desirability of using computers for such problems. A feature of this routine is the ability to have more than one functional equation.

I90-3Ø032 Chemistry and Chemical Engineering 490. Problem 2. Polynomial Evaluation. Write a function subprogram in SCATRE to evaluate a polynomial in two variables, x and y. The polynomial is of order N in x and M in y and the coefficients are stored in FORTRAN format.

$$z = a_{00} + a_{01}x + \ldots a_{0n}x^n + a_{10}y + a_{11}yx + \ldots a_{1n}yx^n + a_{21}y^2x + \ldots a_{mn}y^mx^n$$

where: $a(1,1) = a_{00}$; $a(1,2) = a_{01}$; etc.

Carry double precision throughout the computation and round the result to single precision. The calling sequence in FORTRAN should be: Z = PØL (X,Y,N,M,A,MD) where A appears in a dimension statement: A(MD,ND).

Write a FØRTRAN driver program which will read N and M from a card (2I3) and the matrix A, five elements per card by rows (5E15.8). Print N, M, and the matrix A. Then read x and y from a card and print x, y, and z. Read another X and Y and repeat until a blank card is encountered. Then start over.

I91-3Ø034 Civil Engineering 391. Problem 2. Traverse Balancing by the Compass Rule. In a previous programming assignment a program to compute the error of closure in a traverse was written. This assignment consists of extending the program to perform the traverse balancing by the compass rule, and to compute the corrected coordinates of the survey points.

The compass rule is stated as follows:

"The correction to the latitude (or departure) of a course is to the total error in latitudes (or departures), as the length of the course is to the perimeter of the field."

The program should read two additional quantities, the X and Y coordinates of the starting point.

If the error of closure (ERRØRC) is greater than $\frac{1}{10,000}$ of the perimeter, the program should print an error message and go on to the next set of data. If the error of closure is less than the given tolerance, the program should perform the balancing and print NSIDE lines, as follows:

Side No	Corrected Departure	Corrected Latitude	X coordinate	Y coordinate

The last two columns refer to the coordinates of the end point of the side.

The program should be self-resetting, i.e., be able to process an arbitrary number of independent sets of data.

Test the program with the data set provided (which violates the tolerance criterion), and the following set:

Side	Bearing	Distance
1	N 9.50E	575.40
2	S 69.20E	495.30
3	N 58.70E	558.70
4	S 6.68E	738.70
5	N 87.38W	1122.10

$X_1 = 1000.00$ $Y_1 = 2000.00$

I92-3Ø045 Civil Engineering 316. Problem 1. CE316-Problem 1. This problem is on the use of the critical Path Method Program.

The use of this program by the students will merely involve their preparing data and using the already existant program binary deck in order to carry out a scheduling optimization problem.

I93-3Ø054 Electrical Engineering 343. Problem 1. Feedback Amplifier. This problem involves finding the solution of a set of equations describing a vacuum tube feedback amplifier using the complex equation solving subroutine.

Information on the utilization and reliability of the IBM 1401 and IBM 7094 for the month of October, 1963 is given in the tables below.

TABLE I - IBM 1401 - I

Summary of Use

October, 1963

Scheduled Engineering	10:25
Unscheduled Engineering	21:58
Maintenance	4:29
7094 Preparation	366:10
Listing	6:23
Monthly Report Listing	3:29
Tape Dump	5:13
Code Check	11:22
Scanning Measuring Projector	27:08
Reproduction	3:29
Tape Test	6:10
Tape Copy	1:20
Tape Rewind	:20
CDC Preparation	:11
Idle	136:41
	603:48

TABLE II - IBM 1401 - I

Summary of Machine Errors

October, 1963

1401 Main Frame and Storage	0
1402 Read-Punch	4
1403 Printer	6
729 V Tape Units	1
	11

IBM 1401-I TABLE III - OCTOBER 1963

DATE	OK RUNNING	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURES	1401 - I DAILY DISTRIBUTION TIME
10/1/63	14:35			:40	8:45	24:00	0	
10/2/63	22:00			:10	1:50	24:00	0	
10/3/63	13:00	2:55			8:05	24:00	0	
10/4/63	24:00					24:00	2	(1) Ribbon reverse on 1403 does not always function properly. (2) Stackers on 1402 do not stop machine when full.
10/5/63	11:00					11:00	1	(1) Consistent SYNC and PRINT checks on 1403 due to dirty chain.
10/6/63	10:08					10:08	0	
10/7/63	14:24			:16	9:20	24:00	0	
10/8/63	14:55			:05	9:00	24:00	1	(1) Tape Unit A fails to back-space properly. Defective motor found.
10/9/63	11:00		3:30	:25	9:05	24:00	0	
10/10/63	13:48	2:00	:30	:25	7:17	24:00	0	
10/11/63	16:10		4:05		3:45	24:00	0	
10/12/63	4:15			:30	3:15	8:00	0	
10/13/63	3:05					3:05	0	
10/14/63	13:49	1:45	:45		:51	17:10	1	(1) Punch stops on 1402 caused by dust accumulation.
10/15/63	18:49				5:11	24:00	0	
10/16/63	13:10		2:35		8:15	24:00	1	(1) New plastic shims installed on 1403 to repair hammers.
10/17/63	14:25		1:30		8:05	24:00	0	
10/18/63	9:56		4:00		10:04	24:00	0	
10/19/63	5:05				2:55	8:00	0	
10/20/63	3:30					3:30	0	
10/21/63	12:39	2:15			1:06	16:00	0	
10/22/63	21:28	:45		:20	1:27	24:00	0	
10/23/63	17:13		:48	:08	5:51	24:00	1	(1) Upper tractor cover fell off, units were switched.
10/24/63	17:05			:15	6:40	24:00	1	(1) Consistent carriage run-aways on 1403.
10/25/63	13:35		4:15	:15	5:55	24:00	2	(1) Punch jam resulted in damage to brushes on 1402. Brushes replaced. (2) Timing belt on 1402 punch cams was worn out.
10/26/63	7:35			:15	10:10	18:00	0	
10/27/63	11:55			:25	:35	12:55	0	

DATE	OK RUNNING	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURES	1401 - I DAILY DISTRIBUTION TIME
10/28/63	15:15				:45	16:00	0	
10/29/63	18:37				5:23	24:00	0	
10/30/63	21:30			:10	2:20	24:00	0	
10/31/63	22:19	:45		:10	:46	24:00	1	(1) Consistent SYNC checks on 1403 due to dirty chain.
	430:15	10:25	21:58	4:29	136:41	603:48	11	

TABLE I - IBM 1401 - II

Summary of Use

October, 1963

Scheduled Engineering	4:00
Unscheduled Engineering	21:27
Maintenance	6:20
7094 Preparation	325:48
Listing	9:57
Monthly Report Listing	1:42
Tape Dump	5:17
Code Check	3:37
Scanning Measuring Projector	11:15
Reproduction	3:23
Tape Test	13:20
Tape Copy	:45
Hardware Monitor	:15
Idle	169:26
	576:32

TABLE II - IBM 1401 - II

Summary of Machine Errors

October, 1963

1401 Main Frame and Storage	1
1402 Read-Punch	4
1403 Printer	1
729 V Tape Units	0
	6

DATE	OK RUNNING TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	IDLE	TOTAL RUNNING TIME	FAILURES	1401 - II DAILY TIME DISTRIBUTION
10/1/63	10:05			:30	13:25	24:00	0	
10/2/63	12:55			:10	10:55	24:00	0	
10/3/63	14:50			:15	8:55	24:00	0	
10/4/63	:09		10:30		13:21	24:00	1	(1) Punch-check errors. Two brushes replaced.
10/5/63	:00				8:00	8:00		
10/7/63	7:38		8:00	:20	:02	16:00	1	(1) Unknown
10/8/63	18:30		:55		4:35	24:00	1	(1) Punch-errors. Trouble did not reoccur.
10/9/63	18:45			:15	5:00	24:00	0	
10/10/63	22:40	1:05		:15		24:00	0	
10/11/63	18:30		:30		5:00	24:00	1	(1) 1403 would not come out of neutral; drive control was corrected.
10/12/63	4:35			:30	2:55	8:00	0	
10/14/63	10:10			:30	5:20	16:00	0	
10/15/63	15:58				8:02	24:00	0	
10/16/63	15:49			:10	8:01	24:00	0	
10/17/63	18:10			:15	5:35	24:00	0	
10/18/63	17:14				6:46	24:00	0	
10/19/63	4:10				3:50	8:00	0	
10/21/63	15:25			:35		16:00	0	
10/22/63	19:30	1:15		:30	2:45	24:00	0	
10/23/63	20:25			:15	3:20	24:00	0	
10/24/63	20:35			:15	3:10	24:00	0	
10/25/63	20:25			:30	3:05	24:00	0	
10/26/63	12:05			:05	7:50	20:00	0	
10/27/63	7:17			:15	5:00	12:32	0	
10/28/63	12:45	1:40	1:15		:20	16:00	1	(1) Two brushes replaced in read side of 1402.
10/29/63	:30				23:30	24:00	0	
10/30/63	16:22		:17	:20	7:01	24:00	1	(1) Power hook-up.
10/31/63	19:52			:25	3:43	24:00	0	
Totals	375:32	4:00	21:27	6:20	169:26	576:32	6	

TABLE I - IBM 7094

Summary of Use

October, 1963

Scheduled Engineering	37:34
Unscheduled Engineering	28:46
Production	551:27
System Updating	7:16
Demonstration	:50
Instruction (28018)	1:12
Miscellaneous (Tape rewind, tape mounting, both system and user, rerun of failing problems, tape skipping, destruction of clock reading)	117:55
	745:00

TABLE II - IBM 7094

Summary of Machine Errors

October, 1963

Arithmetic Unit	3
729 VI Tape Units	9
CRT	2
Disk File	4
711 Card Reader	1
Fortran Errors	1
	20

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	OPERATOR MANIPULATION	TOTAL RUNNING TIME	FAILURE	IBM 7094 DAILY DISTRIBUTION TIME
10/1/63	8:48	4:25	6:50	3:57	24:00	0	Error on previous day. Check sum error. Found bad card in 7109. Scheduled engineering for installation of hardware monitor.
10/2/63	16:10	3:52	:09	3:49	24:00	2	(1) CRT not working properly. Leads were loose. (2) I/O power check on Channel A. Probably due to overheating. Power restored. Scheduled engineering for installation of hardware monitor.
10/3/63	16:47	1:45	:49	4:39	24:00	2	(1) Read errors on Master Tape 1. Diagnostic tests did not fail. (2) Same error repeated. Used new tape. Trouble disappeared.
10/4/63	17:41	1:30		4:49	24:00	0	
10/5/63	24:00				24:00	0	
10/6/63	24:00				24:00	0	
10/7/63	16:31	1:24	2:35	3:30	24:00	2	(1) 711 card reader will not read cards. Spring in clutch broken. (2) Some jobs on input tape not processed. Bad card found next day in frame of 7109.
10/8/63	14:03	:40	6:32	2:45	24:00	1	(1) Tape unit Q would not unload. Capstan stuck.
10/9/63	17:07	:35	1:50	4:28	24:00	1	(1) Trouble referencing tape B4. Bad card found in Channel B.
10/10/63	18:47		:50	4:23	24:00	1	(1) Tape unit V had a roller sticking. Taken off line and magnet adjusted.
10/11/63	18:06	:30	:13	5:11	24:00	1	(1) Tape unit V giving many errors.
10/12/63	22:10		1:10	:40	24:00	0	Tape unit V adjusted.
10/13/63	24:00				24:00	0	
10/14/63	19:29	1:22		3:09	24:00	0	
10/15/63	13:39	1:15	4:30	4:36	24:00	1	(1) Errors in FORTRAN due to address register receiving high count. Adjustments made.
10/16/63	16:47	2:35		4:38	24:00	0	
10/17/63	17:42	:27		5:51	24:00	0	
10/18/63	17:48	1:26		4:46	24:00	0	
10/19/63	20:15	3:00		:45	24:00	0	Scheduled engineering to install the manual file protect switches on tape units.
10/20/63	24:00				24:00	0	
10/21/63	18:10	1:30		4:20	24:00	2	(1) Failures due to bad tape on B1. (2) Tape unit X did not recognize reflective spot at end of tape.
10/22/63	16:53		1:15	5:52	24:00	1	(1) Random errors on disk. Trouble disappeared before it could be located.
10/23/63	16:33	2:08	1:53	3:26	24:00	1	(1) Random errors on disk appear again. Replaced a bad card in 7631 file control.
10/24/63	15:55	:15		7:50	24:00	0	

IBM 7094 - TABLE III (Continued)

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	OPERATOR MANIPULATION	TOTAL RUNNING TIME	FAILURE	IBM 7094 DAILY DISTRIBUTION TIME
10/25/63	16:41	1:43		5:36	24:00	0	
10/26/63	23:11		:10	:39	24:00	1	(1) Tape unit V had excessive read errors. Checked but nothing found wrong.
10/27/63	21:15			3:45	25:00*	0	
10/28/63	17:51	1:20		4:49	24:00	0	
10/29/63	15:48	2:02		6:10	24:00	1	(1) Right roller stuck on unit Z. Released by hand.
10/30/63	14:36	2:00		7:24	24:00	2	(1) CRT not taking accurate pictures. Found centering adjustment was off. (2) Random errors in FORTRAN.
10/31/63	16:02	1:50		6:08	24:00	1	(1) Unable to update system. Appears to have not loaded properly.
	560:45	37:34	28:46	117:55	745:01	20	

* Change from CDST to CST resulted in a 25 hour day.

DEPARTMENT	Number of Runs				Number of Problem Specifications				Total Time Used			
	Classes	Research	Non System	Total No. of Runs	Classes	Research	Non System	Total No. Prob. Spec.	Classes	Research	Non System	Total Time Used
Aeronautical and Astronautical Engineering	13	82		95	1	6		7	:16	1:35		1:51
Agricultural Engineering		223		223		4		4		4:19		4:19
Agricultural Economics		179	29	208		5	4	9		2:54	23:30	26:24
Agricultural Education		1		1		1		1		:12		:12
Agronomy	172	150		322	1	13		14	1:26	2:20		3:46
Animal Science		10		10		2		2		:18		:18
Astronomy		45		45		3		3		:50		:50
Bureau of Economic and Business Research		142		142		3		3		2:21		2:21
Biophysics		16		16		2		2		1:24		1:24
Civil Engineering	461	1028		1489	7	30		37	4:41	28:57		33:38
Chemistry and Chemical Engineering	197	1160		1357	2	35		37	2:19	48:09		50:28
Communications		25		25		1		1		:07		:07
Center for Zoonoses Research		15		15		1		1		:11		:11
Digital Computer Laboratory	412	885	3	1300	2	24	3	29	2:58	30:51	1:24	35:13
Dairy Science		54		54		2		2		1:02		1:02
Economics		83		83		4		4		3:25		3:25
Education		74		74		6		6		2:42		2:42
Electrical Engineering	286	262		548	7	17		24	3:05	3:52		6:57
Forestry		4		4		1		1		:41		:41
General Engineering		24		24		2		2		:25		:25
Business Administration, Graduate School	62	14		76	2	1		3	:47	:22		1:09
Home Economics		1		1		1		1		:01		:01
Institute of Communications Research		85		85		2		2		1:42		1:42
Industrial Engineering	231	3		234	3	1		4	:50	:01		:51
Industrial Education		2		2		1		1		:09		:09
Institute of Government and Public Affairs		7		7		1		1		:15		:15
Instructional TV		76		76		2		2		2:28		2:28
Institute for Research on Exceptional Children		3		3		1		1		:05		:05
Mathematics	3038	17		3055	2	4		6	9:39	:07		9:46

IBM 7094 - TABLE IV (Continued)

DEPARTMENT	Number of Runs				Number of Problem Specifications				Total Time Used			
	Classes	Research	Non System	Total No. of Runs	Classes	Research	Non System	Total No. Prob. Spec.	Classes	Research	Non System	Total Time Used
Mechanical Engineering	36	570		606	3	19		22	:19	14:50		15:09
Mining, Metallurgy and Petroleum Engineering		78		78		2		2		2:20		2:20
Men's Residence Hall Association Rocket Club		36		36		1		1		:44		:44
Nuclear Engineering		194		194		4		4		8:16		8:16
Office Instructional Research		48		48		2		2		:44		:44
Physics		1705	55	1760		25	2	27		38:07	250:49	288:56
Psychology		457		457		32		32		20:47		20:47
Psychiatry		28		28		1		1		:38		:38
Sociology		74		74		2		2		:56		:56
Statistical Services Unit		509		509		1		1		12:49		12:49
State Water Survey		114		114		11		11		4:49		4:49
Theoretical and Applied Mechanics		148		148		9		9		2:39		2:39
Sub Total	4908	8631	87	3626	30	285	9	324	26:20	249:24	275:43	551:27
Instruction		166		166		1		1		1:12		1:12
Grand Totals	4908	8797	87	13792	30	286	9	325	26:20	250:36	275:43	552:39

PART V

GENERAL LABORATORY INFORMATION

Colloquia

"Universal Embedding Spaces for Finite Automata," by Professor John H. Holland, Communication Sciences, The University of Michigan, Ann Arbor, Michigan, October 7, 1963.

"On-Line Remote Station Operation," by Professor Gernot Metze, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, October 14, 1963.

"An Evaluation of Integrated Circuits on Systems," by Mr. Forrest Salter, Argonne National Laboratory, Lemont, Illinois, October 21, 1963.

"The CIRRUS--A Low Cost Multiprogram Computer With Microprogram Control," by Mr. Gordon A. Rose, Research Associate, University of Adelaide, Australia, October 28, 1963.

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	15	1	15.5
Visiting Faculty	5	1	5.5
Research Associates	3	0	3.0
Graduate Research Assistants	3	49	27.17
Graduate Teaching Assistants	0	5	2.23
Professional Personnel	5	2	6.0
Administrative and Clerical	10	0	10.0
Other Nonacademic Personnel	47	73	80.6
TOTAL	88	131	150.0

The Computer Advisory Committee consists of Professors H. C. Brearley, J. R. Ehrman, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During October a total of 98 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	5	6
Medium Drawings	5	2
Small Drawings	4	4
Reports	46	0
Change Orders	1	0
Printed Circuits	0	0
Miscellaneous	25	0
TOTAL	86	12

(K. Law, P. Richardson)

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM

PART II - ILLIAC II SYSTEM PROGRAMMING AND OPERATION

PART III - CIRCUIT RESEARCH PROGRAM

PART IV - MATHEMATICAL METHODS

PART V - IBM 7090-1401 SYSTEM

PART VI - GENERAL LABORATORY INFORMATION

NOVEMBER 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. <u>New Construction - Electronics Shop</u>

In terms of transistor counts, the following progress has been made during November.

Printed circuits wired (187 cards)	1141 Transistors
Printed circuits repaired (38 cards)	

(F. Serio)

2. <u>New Construction - Mechanical Shop</u>

The printed circuit facility processed the following:

	For ILLIAC II	Total
New layouts completed	4	7
Layouts revised	1	2
Prototype boards wired	3	4
Complete boards	362	420

The mechanical shop completed the following:

5 male regulator frames

4 female regulator frames

9 male turn-on frames

9 female turn-on frames

2 vertical voltage bus bars for PCB racks

4 experimental power supply boxes

(T. E. Kerkering)

. Component Testing

During the month acceptance tests were run on 22,500 diodes ncluding 20,800 TI 59 as well as on 7000 transistors mainly of the 2N967 amily.

In addition, detailed data was recorded on samples for recent nd proposed purchases. Samples of 1N995 diodes from Sylvania were found o be inferior to those normally obtained from Hughes. Our normal pre- edures for discarding units with less than 20 volts reverse will elimin- te more than half of the Sylvania product.

(B. Doden)

. Circuit Book

A new numbering system for the 415 Circuit Book was published long with a listing of each circuit and the boards on which they appear. ll the circuits, new and revised, are being labelled 415 PC to distinguish hem from the 1018 circuits.

(D. Collins)

5. General Maintenance

. Oscilloscopic observation of logic signals and collector voltages was ompleted on the drum with the following results:

DC5N	→	collector of 219, open diode
DC6N	→	collector of 227, open diode
D1353 #6	→	Bay 2S transistor 72, sensitive to scope probe
D1353 #4	→	Bay 2N transistor 72, sensitive to scope probe
D1353 #2	→	Bay 4N transistor 62, sensitive to scope probe
D1353 #2	→	Bay 1N transistor 62, sensitive to scope probe

B. A regulator drift check was run and as a result Bay 3R, +6.8 o/u, Bay 7R, +25 o/u, Bay 14R, +6.8 o/u were repaired.

C. Timing tests were run for a check against the original ones. Results are recorded in Engineering Log November 15, 1963, page 12.

D. Marginal voltage tests were run on the main frame on consecutive weeks using DAMN and ETR. The numbers shown on the table below represent the percentage change in the indicated voltage when a program failure occurred. Eleven (11) large areas of the main frame out of twenty four (24) operated properly throughout a ± 10 percent voltage change.

	DAMN				ETR			
	+25		-50		+25		-50	
	+ %	- %	+ %	- %	+ %	- %	+ %	- %
2F				10		10		
3F		9			9			
5F				10				
6F		8			9			
8F		7△						
9F					*			
10F						*		
1R								10
3R					10			
4R		10	9				8	
5R	9			9	8		10	
7R	10	9						
14R							9	

* Bad amplifier cards -- repaired

△ This was found and repaired

(L. L. Byers)

E. Checks were made on overshooting collector wave forms reported previously by C. E. Carter and L. L. Byers. Most of the difficulty was finally traced to an oscilloscope trouble. The indicated open collector diodes were replaced as well.

(S. P. Krabbe)

6. Delayed Control

A logic error in the operation of NDV, originally detected by Melman on Golem,has been repaired following a suggestion by J. O. Penhollow. The first 150 pages of Dr. Penhollow's report on the arithmetic subsystem have been proofed.

(R. Kingsley, L. Byers)

7. Indicator Panel

A complete check and repairs were made on the indicator panel. Delayed control selector replies and block checker indicator remain incomplete. Block checker chassis are being modified.

Core parity indication has been changed to light on a parity error.

(R. F. Kingsley, T. Kerkering)

8. Spare Chassis

Spare flow gating chassis are proceeding as follows:

D994 #5	has been started
D997 #9	complete except for diodes
D993 #5	DC checked, tried in machine, troubles not all found
D996 #9	DC checked and operating

(H. Lopeman)

9. Interplay Channel Controls

A general Cable-Pallet-Rack layout for all cabinets containing Interplay Channel Controls has evolved and will be put in general use. The jumpering on these racks will be twisted pair.

(S. P. Krabbe)

10. IBM 1401 Channel

A cleanup of the 1401 logic and wiring has been in progress. A revised character orientation logic has been developed and installed in this channel. Final logic drawings are in preparation.

(S. P. Krabbe)

11. Special Registers

A manual set was wired into Sn8-a and Sn9-a in special register 35_8 drivers. Special register tables are being developed.

(S.P. Krabbe)

12. IBM 1460 System

An IBM 1460 was placed on order this month, to be delivered in early 1965. The system is similar to the 1401, but operates at twice the speed, has a double-speed line printer, and has interrupt facilities. Additionally, the system ordered will have a card reader/punch, one magnetic tape transport, a disk file, a console with console typewriter, and a control unit to handle parallel character transfers to up to 40 IBM 1050's. The 1460 will be tied to ILLIAC II via an Interplay Channel which will be similar to the 1401 Channel.

(R. E. Willard)

13. IBM 1301 Channel

It was decided this month to add an A. C. order to allow transfers of greater than one block to occur. This will allow the use of the full-track operations and the full-cylinder mode on the disk files. This change also requires a more sophisticated scheme for read-only protection of sections of file storage. The channel design is being modified accordingly.

(R. E. Willard)

The command orders for the first 1301 Channel have been tentatively established. Typical ICC logic will be modified for this channel, in that word buffers will have two purposes, namely, storing 52 data bits and a 10 4-bit command orders alternatively.

(R. E. Willard, Y. Yen)

4. IBM 1414 Channel

The Special Register associated with the 1414 has been completely checked out and operates as desired except for one anomalous case. Checkout has been halted for the installation of twisted pair as interrack jumpers for all generally distributed signals and a relatively permanent power distribution system. The anticipated completion date of the above work is December 9, at which time checkout of the anomaly above and the data transfer section of the channel will commence.

(R. E. Willard, M. Pisterzi)

5. Console Switch Register

The console manual input-output register, temporarily labelled R28, has been installed and is expected to be checked out in December. A file report on its use and operation will be issued.

(J. Bouknight, H. E. Lopeman)

6. Console Typewriter, SR 76

Preliminary specifications have been assigned and logic design has been started. It is expected that installation will be completed and checkout started towards the end of December. A file report on the preliminary specifications is in preparation.

(J. Bouknight, G. Metze)

An alternative logical design of Special Register 76_8, to be used for connection of the IBM Selectric Typewriter to ILLIAC II is proceeding.

(H. Hsu, D. Tabak)

17. Remote Tape Switching

Circuitry to enable tapes to be switched between the 1401 and 1414 by program control is being prepared.

(D. Collins)

18. Engineering Test Programming

An updated version of the Automatic Engineering Control for multiprogramming was checked out in NICAP. This routine permits, by means of parameters, the inclusion of any subprogram, the specification of the interrupt conditions desired and the specification of the cycle time allotted to each subprogram.

When a cycle is terminated by a clock interrupt, the point of interrupt and all accessible registers (excluding R and ES) are saved. Corresponding data for the next subprogram are then substituted from storage and control is transferred to its point of interrupt. All storage locations are reserved automatically by the A. E. C. program.

(G. E. Cooper, M. Levin)

Program interrupt tests are being written for use with A. E. C.

(M. Levin)

Work has begun on a simple paper tape compiler for engineering test purposes. It will allow the spur-of-the-moment testing of any major D. C. order with arbitrary operands.

(G. E. Cooper)

The new ETR control has been revised to be compatible with the Automatic Engineering Control. In particular, interrupt tests may now be used with the ETR system.

(G. E. Cooper)

Octal input in Bootstrap format, used as leader for many system tapes, has been rewritten to eliminate the use of JDC 1, c, n, as a null order since the meaning of this instruction is controversial.

(M. Levin)

Test programming to aid in the debugging and checkout of the IBM 1414 Channel has continued. A complete set of test programs is being written.

Shift Tests (P1-SFT-552) are being converted to be made compatible to the ETR Control.

B. Whitten's Store Tests (P1-STT-562) have been reexamined and are in the process of being corrected and code checked.

A program has been written but not completely code-checked (using NICAP) which activates the IBM 1414 and IBM 1401 Channels simultaneously in order to test for interference between the two channels. The program uses the IBM 1401 to print, punch and read while block transfers are being made between the IBM 1414 Channel and ILLIAC II.

(L. Huszar)

PART II

ILLIAC II SYSTEM PROGRAMMING AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois. Contract No. AT(11-1)-415 is supported jointly by the Atomic Energy Commission and the Office of Naval Research.

1. Manual and Library

The part of chapter 5 of the ILLIAC II Manual dealing with input output conversion has been written and is at the printers. Also at the printers are subroutines

SQR1	Square Root
LAG6	Lagrange 6 point interpolation
LGUN	Lagrange unequal interval interpolation
LGT1 LGE1 LGB1	Logarithm, bases ten, e and two
GQU1	Gauss Quadrature

(C. W. Gear)

2. Input/Output Systems

A specialized program for handling input-output and transfers without conversion has been written for the express use of manipulating data in the reassembling and reworking of NICAP. Except for the part communicating with the 1414, code-checking is complete.

Further work has been done in programming a more diverse input-output (without conversion) subroutine which can branch on "unit busy," or wait until "unit free" as well as handle control operations and normal transfers.

Code-checking has started on the interrupt programs, parts of which will eventually be incorporated into the monitor.

(Judith Aaron)

3. Miscellaneous Programming

The Gauss Quadrature subroutine has been placed in the library. Work has begun on the DIMENSIØN statements for the FØRTRAN Compiler.

(Lorinne L. Lunde)

Corrections and additions have been made to the TRACE routine. Corrections have been made to the EQU subroutine in NICAP. The RUNGE-KUTTA library subroutine is being code checked for the card system.

(F. Schaffer)

Preparations were made for revisions of NICAP assembler.

(T. Slivinski)

Work is continuing on the NICAP version of the INVERSE LAPLACE routine and the DØ loop section of FØRTRAN compiler.

(E.P. Brower)

Modifications on Input/Output With Format are continuing.

(M. Gaer)

4. Operating Log Summary for November, 1963

A. Machine Use

Engineering		
General	78:38	
Drum	73:39	
1414	47:48	
Interplay, etc.	11:38	211:43
Engineering Tests		
Store	3:00	
ETR	2:57	
DAMN	134:06	
BTC	14:53	154:56
Code Checking		88:23
Production		
Gillies	1:55	
Gear	20:08	
Jordan	215:47	
Bouknight	3:40	241:30
Demonstrations		3:19
Power Off		12:01
Idle		8:08
Total Time Running		720:00

B. Error Analysis

ILLIAC II		
Punch	6	
Reader	0	
Power Dump	3	
Unknown	4	13
1401 Equipment		
1401 (Processing Unit)	2	
1403 (Printer)	3	
729 (Tape Drives)	1	
Process Overlap Feature	1	
Power Failure	1	8
Total Number of Errors for System		21

(W. L. Huffman)

5. Component Failure Log Summary, November, 1963

Components

Diodes	7
Transistors	6

Components causing machine stoppage are indicated by use of an (*) with the number. In summary, these are:

Transistors	1

COMPONENT FAILURES FOR THE MONTH NOVEMBER, 1963 - SUMMARIZED DECEMBER 15

COMPONENT	TYPE	LOG NO.	LOCATION	FAULT	REASON	COMMENT
Diode	S577G	1	CE9-134	open	Spontaneous	All are open
	T1G	2	CD20-106	open	Spontaneous	collector
	T1G	3	CD20-108	open	Spontaneous	bumps that
	T1G	4	CD18-170	open	Spontaneous	just happened to
	T1G	5	CD18- 69	open	Spontaneous	be replaced in
	T1G	6	CD18-175	open	Spontaneous	November (all
	T1G	8	CE1- 61	open	Spontaneous	found earlier)
Transistors	2N1309	7	CE1-194	open E-b	Spontaneous	In an unused circuit
	2N1309	12*	DC5S-184	open C-b	Spontaneous	
	2N335	9	3R#3-Q102	$\alpha < .9$	Spontaneous	+6.8 amp card
	2N335	10	2R#0-Q102	$\alpha < .9$	Spontaneous	+25 amp card
	2N335	11	14R#18-Q102	$\alpha < .9$	Spontaneous	+6.8 amp card
	GF45011	13	S8F#181	Low reverse	Spontaneous	+6.8 amp card

(C. E. Carter)

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Henry Guckel established very interesting upper and lower bounds for the impedance of a generalized strip-line. These bounds are obtained from a calculation of the system's total energy and a Green's function approach respectively. Practical calculations showed that the A.M. of the two bounds is within 5 percent of the experimental value for the geometries considered.

Stephen Nuspl tried to solve the tunnel-diode-transistor interface problem by using a two-transistor negative input impedance circuit, the impedance behavior of which was made to approach that of a tunnel diode. Considerable tolerance and speed problems were encountered.

Louis van Biljon ran a first series of experiments on a microplasm diode received from the Shockley Laboratories. The control of the breakdown and the periodicity seem to be still presenting difficulties, but it is felt that pulse-length control (and therefore microplasm logic) is within reach.

2. Tunnel Diode Work

Theoretical Work

a. The calculations of the upper and the lower bound of the intrinsic impedance of a rectangular conductor parallel to two ground plans has been completed. Results are:

$$Z_o^U = \sum_{n=1}^{\infty} \left(\frac{2d^2 Zo}{\kappa n^3 \pi^3 (t + 2\ell)^2} \sin^2 \frac{n\pi(2a + t)}{2d} \right) \left(\frac{2\ell n\pi}{d} \cos^2 \frac{n\pi t}{2d} + \sin \frac{n\pi t}{d} \right.$$

$$\left. - \cos \frac{n\pi t}{d} + \left(1 - \sin \frac{n\pi t}{d}\right) \epsilon^{-\frac{2n\pi\ell}{d}} \right)$$

$$Z_o^L = \sum_{n=1}^{\infty} \frac{Z_o}{\kappa\left(\frac{2\ell}{b} + \frac{2\ell}{a} + \frac{4d^2}{\pi^3 n^3 a^2}\left(\sin\frac{n\pi a}{d} + (-1)^{n+1}\frac{a}{b}\sin\frac{n\pi b}{d}\right)^2\right)}$$

Where (See Fig. 1)

t = Thickness of center conductor

2ℓ = Width of center conductor

d = Spacing between ground planes

b, a = Spacing from ground plane to center conductor

A program was written to evaluate the above expressions for different geometries. Preliminary results show differences: $\Delta = |Z_o^U - Z_o^L|$, which are small enough to allow the results to be used as design tables.

b. The approximate energy stored in the geometry indicated in Fig. 1 was calculated.

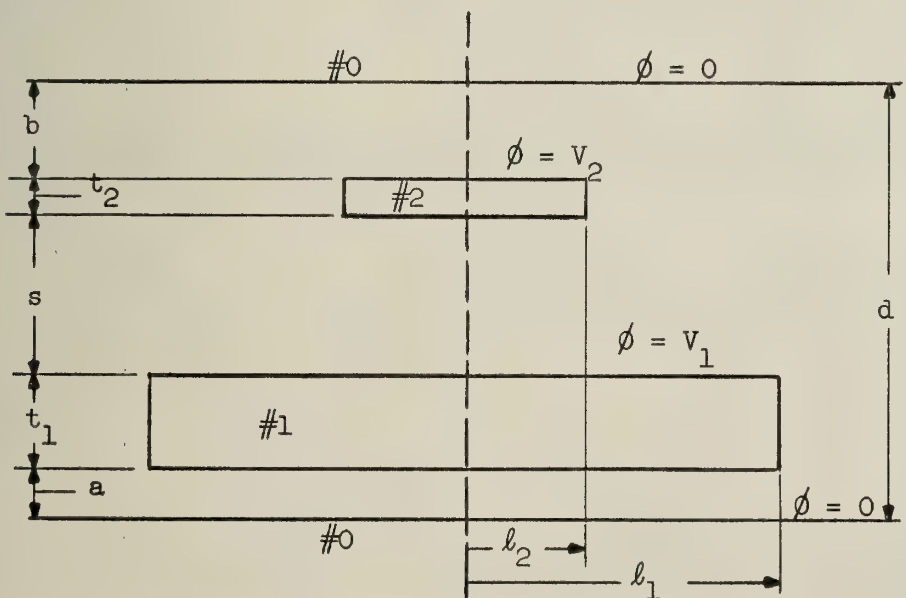


Figure 1. General Broadside Coupled Line.

Results are:

$$W_T = \epsilon \left[\frac{V_1^2 \ell_1}{a} + \frac{V_1^2 (\ell_1 - \ell_2)}{d - t_1 - a} + \frac{V_2^2 \ell_2}{b} + \frac{(V_2 - V_1)^2 \ell_2}{s} + \frac{\pi}{4} \sum_{n=1}^{\infty} n d_n^2 \sinh \frac{2n\pi(\ell_1 - \ell_2)}{d - t_1 - a} \right.$$

$$\left. + \frac{\pi}{2} \sum_{n=1}^{\infty} n f_n^2 \epsilon^{-\frac{2n\pi\ell_1}{d}} \right]$$

Where:

$$d_n = \frac{2}{n\pi} \operatorname{sech} \frac{n\pi\ell_2}{b + s + t_2} \left(\frac{V_2 - V_1}{s} \left(\frac{b + s + t_2}{n\pi} \sin \frac{n\pi(t_2 + b)}{b + s + t_2} \right) \right.$$

$$\left. + \frac{V_2}{b} \frac{b + s + t_2}{n\pi} \sin \frac{n\pi b}{b + s + t_2} - V_1 \cos n\pi \right)$$

$$f_n = \frac{2V_1 d}{n^2 \pi^2 a} \left[\sin \frac{n\pi a}{d} + \frac{a}{b + s + t_2} \sin \frac{n\pi(a + t_1)}{d} \right] \epsilon^{\frac{n\pi\ell_1}{d}}$$

$$+ \left[\frac{2V_2 - V_1}{n^2\pi^2 s} d \left(\sin \frac{n\pi(d - b - t_2)}{d} - \sin \frac{n\pi(t_1 + a)}{d} \right) \right.$$

$$\left. + \frac{2V_2 d}{n^2 \pi^2 b} \sin \frac{n\pi(d - b)}{d} + \frac{2V_1}{n\pi} \cos \frac{n\pi(a + t_1)}{d} \right] \frac{\cosh \frac{n\pi\ell_1}{b + s + t_2}}{\cosh \frac{n\pi\ell_2}{b + s + t_2}} \epsilon^{\frac{n\pi\ell_1}{d}}$$

The even and odd mode impedances have been computed from:

$$C_{10} + C_{12} = \frac{2}{V_1^2} W_T(V_2 = 0)$$

$$C_{20} + C_{12} = \frac{2}{V_2^2} W_T(V_1 = 0)$$

$$C_{10} + C_{20} = \frac{2}{V^2} W_T(V_1 = V_2)$$

These impedances are again lower bounds. Upper bounds are currently being calculated by the use of a suitable Green's function technique.

Experimental Work

The interconnection property of the Goto pair (See Fig. 2) was studied

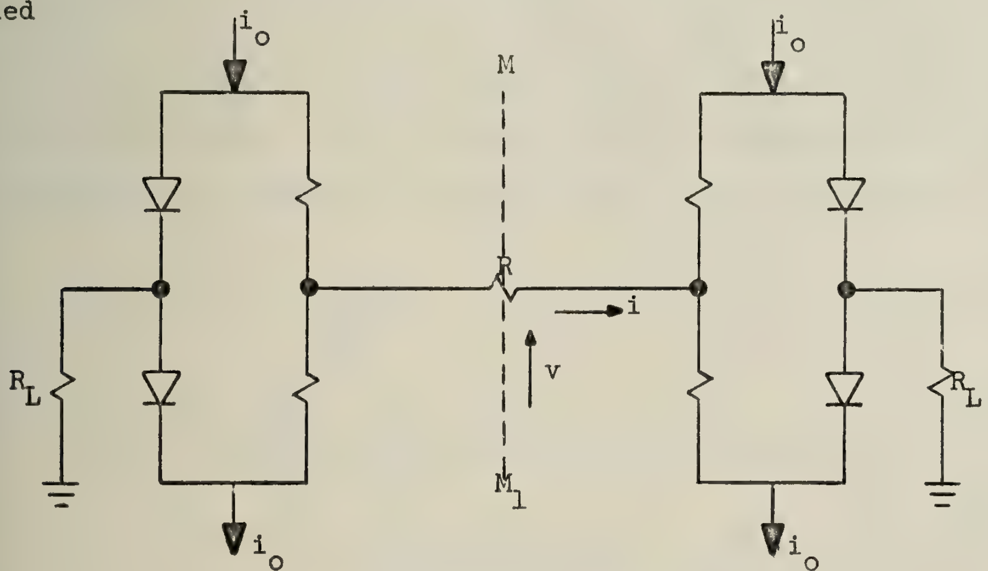


Figure 2. Coupled Goto Pair

The circuit may be analyzed by considering the behavior at the plane of symmetry MM^1.

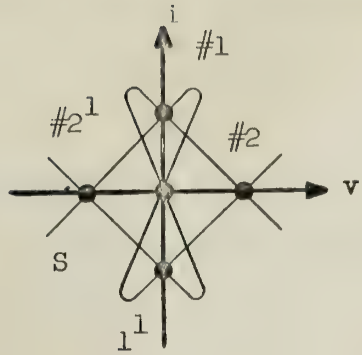


Figure 3. Stable Points for Figure 2. $R_L > |-R|$

Points 1 - 1^1 (See Fig. 3) describe out-of-phase behavior, i.e., the "not" function. Experiments indicate that the circuit may be forced into any one of the four states. However, due to excessive inductance state S was found to be stable also. It is believed that this condition can be corrected. Bias coupling was studied by using the circuit shown in Figure 4.

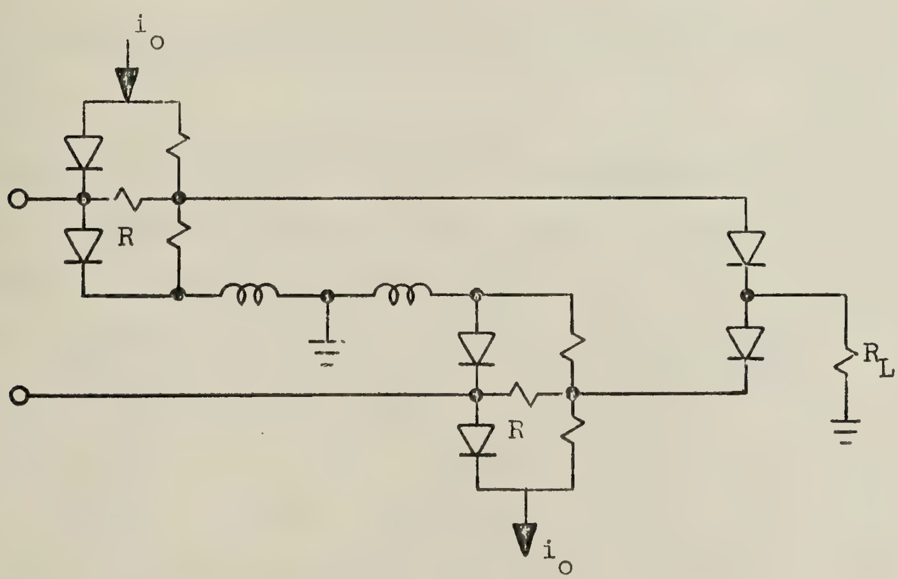


Figure 4. Bias Coupled Circuit

Results are incomplete, but so far indicate very good response and state stability. It is felt that the level-shifted inputs are ideally suited for interconnection to hot electron diodes. These are now commercially available and have been ordered.

3. Tunnel Diode to Transistor Interface

In an attempt to solve the tunnel diode to transistor interface problem the circuits in Fig. 5 was studied.

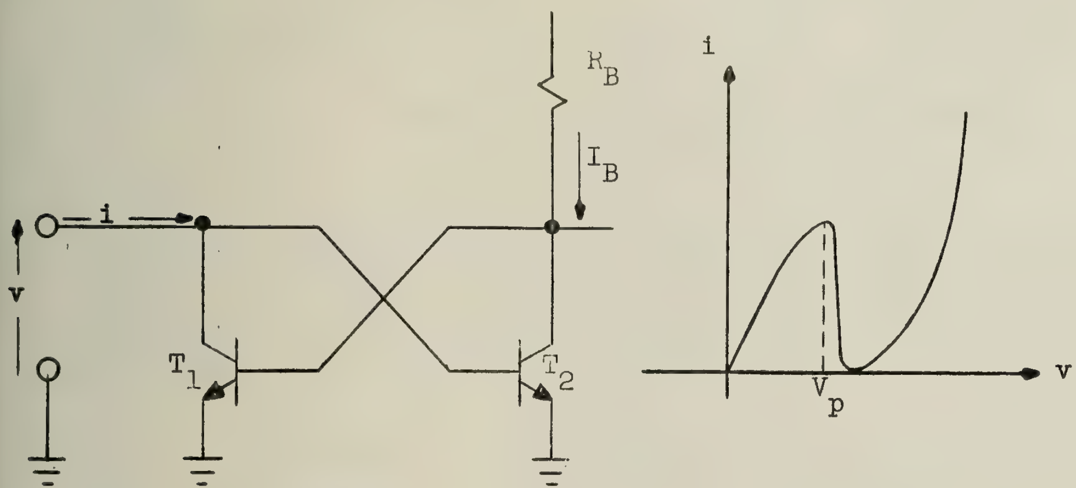


Figure 5. Negative Input Impedance Circuit and Characteristic

A graphical analysis indicated that T_1 is saturated and T_2 off for v less than V_p and T_2 is saturated and T_1 off when v is beyond the negative resistance region. A negative resistance of the order of 5 ohms or less occurs when T_1 switches off and T_2 on. The v - i characteristics are initially the V_{CE} - I_{CE} characteristics of T_1, then the V_{BE} - I_{BE} characteristics of T_2. The position of the peak voltage cannot be easily altered, but the peak current can be controlled by the injected current I_B. A number of different types of transistors were tried in the circuit and in all cases the current peak occurred in the 200 to 300 mv. range. For a fixed bias current I_B, the peak current varied considerably from one transistor to another even though they were of the same type.

To stabilize the peak current against temperature variations and to increase the switching speed a resistor was added in series with the collector of T_1 and the bias current was increased to saturate T_1 more deeply (See Fig. 6).

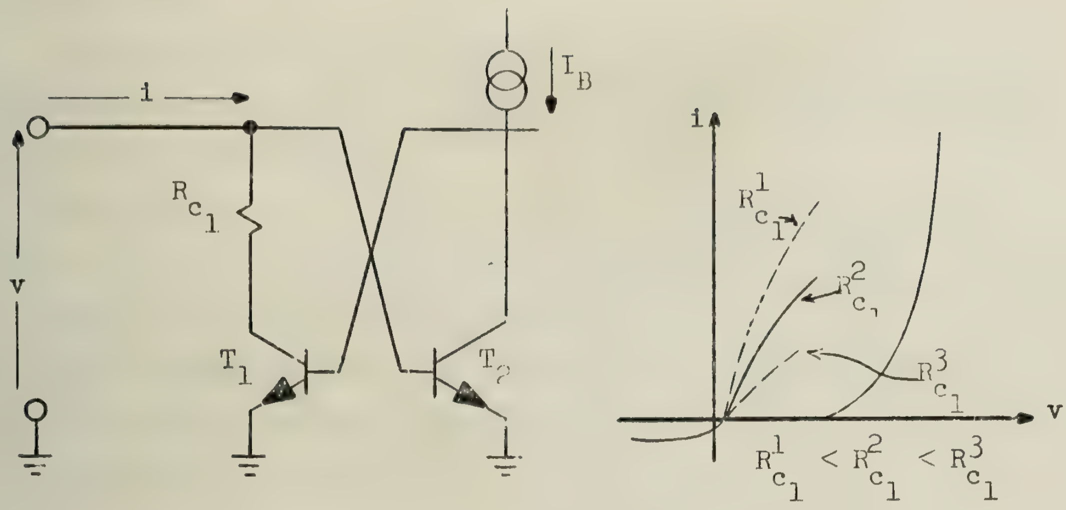


Figure 6. Modified Circuit of Figure 5

This also considerably improved the uniformity of the peak current when different transistors of the same type were used. When biased as a bistable element and connected in an oscillating ring it was found that the element could switch in less than 10 nsec.

Two methods of interconnecting the tunnel diode circuits and this element were proposed. In the first, the element would be connected as a bistable device and the tunnel diode circuitry would be AC coupled to it. Since the tunnel diode circuitry proposed by H. Guckel requires a matched load and will produce only about 5 nsec pulses this method did not work. Two elements were also connected as a Goto pair in the hope of using the negative resistance region. However, the negative resistance of the two elements is already small and the addition of the small source impedance (about 2 ohms) of the bias decreases it more. The resulting negative resistance is so small that it can no longer be used in anything but ideal circuits.

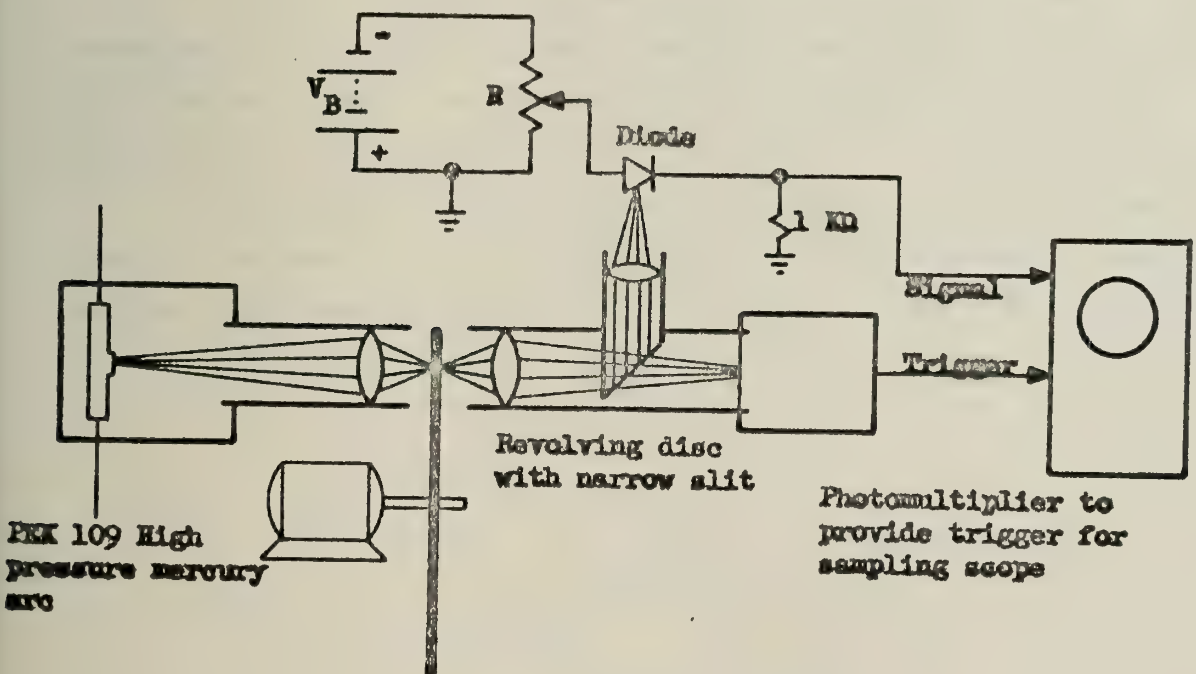
Though this two-transistor element can not be used directly as the interface between the tunnel diode and transistor circuits as initially desired, it does have useful characteristics. Since the peak current can be controlled reasonably accurately by the resistor R_{c1}, and since additional bases can be connected to the collector of T_2, it may be used as a majority logic element. Also, because of the low voltages encountered it is felt that this circuit could find use as an inexpensive, low power storage element.

4. Microplasm Work

An experimental set up has been constructed for observing the breakdown characteristic of the special silicon planar diodes received from the Shockley Laboratories.

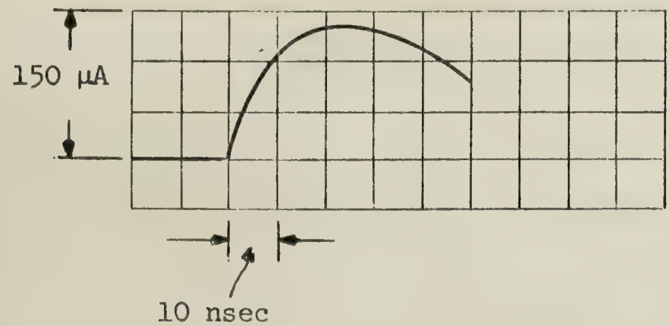
These diodes have extremely 'hard' breakdown characteristics and show typical microplasma type behaviour at the onset of breakdown; the breakdowns, however, are larger (in area) than typical microplasmas. Due to their extremely accurate manufacture, the breakdown is uniform over the entire junction which has a diameter of about 1μ.

The set-up is as follows:



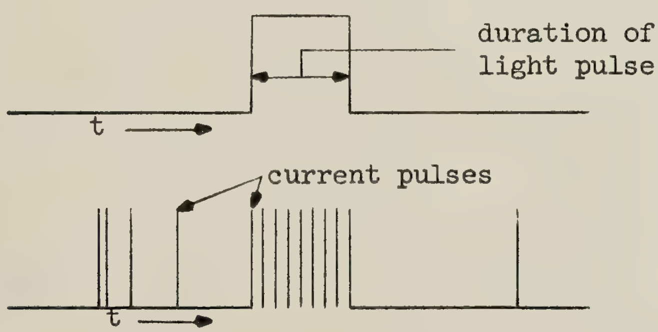
A sampled display has not yet been obtained, possibly due to too much time jitter in the light pulse spacing -- this is being improved at present.

On a 581 oscilloscope (rise time 10 nsec) individual current pulses have been observed of the shape indicated below.



The rise time was limited by the oscilloscope and associated capacitance. The long fall time probably is due to local heating during the pulse since operating the diode immersed in liquid nitrogen decreased the fall time considerably.

It has not been possible to confine the junction breakdown, in time, to the duration of the light pulse; it is obvious though that the applied light pulse greatly increases the number of breakdowns occurring. The observed behaviour is as follows:



This behaviour may be due to the fact that ambient light was present during the experiment, or that other ionizing particles are present.

The average 'ON'-time of the pulses was found to increase rapidly with increased applied voltage -- one diode gave 1 μsec pulses at 21.1 volts.

PART IV

MATHEMATICAL METHODS

(Supported in part by the National Science Foundation under grant G16489.)

A programming error effecting the Wiener integral evaluation programs FJ-17 and FJ-21 was found. These programs were corrected and used to calculate the second virial coefficient of He^4 for several temperatures. Using a Lennard Jones 6-12 interaction potential with potential well depth ϵ and replusive core radius σ determined by de Boer and Michels[1,2] and a fair fit to the experimental virial coefficient versus temperature curve was found. Calculations were begun to determine the values of ϵ and σ which give the best fit to the experimental curve.

(Harry Jordan)

[1] J. de Boer and A. Michels, Physica, 5, 945, 1938.

[2] J. de Boer and A . Michels, Physica, 6, 409, 1939

PART V

IBM 7094-1401 SYSTEM

Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

EW ROUTINES

B4-UØI-DCSR-49-SR Floating Point Double Precision Complex Square Root.

This routine computes the square root of a complex number whose real and imaginary parts are in double precision floating point normalized form.

The double precision arguments and results must be stored such that the more significant part is in an even core location and the less significant part in an odd core location. The arguments should be normalized.

(Eugene Chang)

HO-UØI-CPP1-50-FR Central Path Programming.

A Project Control Method called Critical Path Programming has recently been implemented in FORTRAN source language for running on the IBM 7090 computer system. The programming was done by members of the Operations Research Group assisted by personnel of the Defense Systems Division of the General Motors Corporation.

A good deal of flexibility was built into the program. Various types of computer runs can be made, and alternative forms of output are obtainable. These are described in detail in the body of the available program description.

The program was written under the FORTRAN Monitor System. As this system was applied in this program the computer operator was required to take an active part in the program execution. Since the University of Illinois control system, called PORTHOS, is designed for nearly completely automatic operation, it was necessary to alter the program to comply to this system.

This alteration was carried out by J. B. O'Shea and L. R. Shaffer of the Department of Civil Engineering.

B1-UØI-DATN-51-SR

Floating Point Double Precision Arctangent. This program computes the double precision principal value of arctan x for a double precision floating point number x.

The double precision arguments and results must be stored such that the more significant part is in an even core location, 2n, and the less significant part in the odd core location 2n+1. The argument need not be normalized.

(Eugene Chang)

C2-UØI-DPRT-52-SR

Double Precision Floating Point Polynomial Root Finder. This subroutine coded in SCATRE uses 7094 double-precision operations to compute the roots of a polynomial equation with complex coefficients:

$$a_1x^N + a_2x^{N-1} + \dots + a_Nx + a_{N+1} = 0$$

where

$$a_k = A_k + iB_k$$

A_k, B_k are double precision real numbers.

This routine is based on an iterative method developed by D. E. Muller of the University of Illinois. Although convergence of the method has only been proved for single and double roots it does occur for most practical cases tested.

(Eugene Chang)

C2-UOI-DPPR-53-SR <u>A General Program for finding Double Precision Floating Point Polynomial Roots.</u> This is a complete or "canned" program. The user need do no programming.

An input-output structure is built around subroutine DPRT (above) (with slight modification) to compute the roots of a polynomial equation with complex coefficients.

$$a_1x^N + a_2x^{N-1} + a_3x^{N-2} \; x \ldots a_Nx + a_{N+1} = 0$$

where

$$a_k = A_k + iB_k$$

A_k, B_k are double precision real numbers.

The degree of the polynomial, N, must be less than or equal to 50; however, this restriction can be removed by reassembling the routine with increased storage block size reserved for the coefficients A, B, C and D.

This routine was programmed and modified to double precision from an original "GAT" program on the IBM 650 by William A. Wulf, Digital Computer Laboratory, University of Illinois.

(Eugene Chang)

During the month of November, 32 problem specifications were submitted to the IBM 7094.

637-3ø063 Psychology. The Culture Fair and Pre-School Personality Questionnaires. The structure of intelligence and personality of preschool children is to be studied. Part of this will involve constructing and standardizing the Culture Fair Intelligence Scale 1 and the Preschool Personality Questionnaire. Primarily factor analysis, rotation, and item analysis will be carried out.

638-3ø064 Psychology. Measurement of Job Satisfaction. This study will compare and attempt to evaluate a number of different methods of measuring job satisfaction. Several methods of weighting and combining satisfaction with various aspects of the job (such as salary, supervisor, coworkers) into an overall job satisfaction score will be used, including:- having the subject check the degree of importance of each aspect to him on an eight-point scale, having the subject rank the various aspects in order of their importance to him, and having the subject respond to a newly developed questionnaire. Analysis of the questionnaire requires the calculation of two 2x2x2x2 analyses of variance for each subject. This will be done on the computer.

The reliability of the analysis of variance method will be determined. If it is sufficiently high, the following analysis will be conducted.

Satisfaction with the job aspects will be determined by two separate questionnaires, one of which will be factor analyzed on the computer in order to ascertain its underlying dimensions. The various weighting methods will be applied to each questionnaire to obtain an overall score. Separate measures of overall satisfaction will be obtained. All data will be intercorrelated on the computer to determine which of the weighting methods best predicts scores on the overall satisfaction measures. It is hypothesized that the analysis of variance method, due to certain theoretical considerations, will prove superior to the others.

639-3ø067 Bureau of Economic and Business Research. Analysis of Consumer Data. The general nature of the problem will be a regression analysis of savings by consumers.

640-3ø068 Psychology. Recognition Accuracy. The purpose of the analysis is to determine 288 d' measures. The d' value is a measure of the subject's recognition accuracy of briefly presented stimuli and is described in the context of signal detection theory.

The data are obtained from the subject's performance or a visual recognition task. Recognition accuracy is being measured as a function of stimulus complexity, association value, and delay between initial and subsequent presentation of a stimulus.

641-3N001 Theoretical and Applied Mechanics. Creep of a Beam Column. A beam column made of a material that creeps will be loaded with arbitrary concentrated and distributed loads. An axial load of varying magnitude and eccentricity will be applied. All loads are in a plane of the principal moment of inertia. Each end of the beam column will be restrained by a moment which is proportional to the slope of the centroidal axis at that point.

The assumed stress-strain relation for the column is:

$$\sigma = \sigma_0 \operatorname{arcsinh} \epsilon/\epsilon_0 ,$$

where σ denotes stress in psi, ϵ denotes strain in in./in., and ϵ_0 and σ_0 are experimental constants.

The computer will be used to calculate lateral deflections.

642-3N004 Psychology. Personality and Cognitive Meaning. Previous researchers have claimed one-to-one correspondence between personality factors obtained by self-ratings and those obtained from ratings by others. This research problem is an attempt to examine the correlations between factors or traits obtained by such various methods. Three instruments, The Sixteen Personality Factors Questionnaire, a Semantic Differential, and two 7-point scales of Adjustment and Extraversion-Introversion, are used to obtain self-ratings. Ratings by others are obtained by the same three instruments, except that the 16 personality factors are administered in the form of 7-point scales rather than as a questionnaire. These ratings are obtained from the subject's father, mother, a peer of the same sex, and a peer of the opposite sex. The data on the 16 personality factors, both in the form of the questionnaire and the 7-point scales, are scored for first-order factors; all three instruments are scored for the large second-order factors of Adjustment and Extraversion-Introversion. Thus scores on 24 variables each are obtained from five ratings per subject: self, father, mother, peer of same sex, and peer of opposite sex.

The 7094 is used to obtain coefficients of correlation between personality factors (traits) across the several instruments and sources of ratings. These correlations are then placed in multitrait-multimethod matrices to be examined for convergent and discriminant validity. Data for those subjects (N=60) for whom all five ratings were obtained are grouped in three ways: one self-rating and four ratings by others, one self-rating, ratings by mother and father grouped into

one parent-rating, and ratings by same and oposite sex peers grouped into one peer-rating, and one self-rating and all four ratings by others grouped into one other-rating. Data for additional subjects (N=41), for whom a self-rating plus ratings by at least one parent and one peer were obtained, are grouped in one way only (one self-rating, one parent-rating, and one peer-rating) and serve the purpose of cross-validation.

643-3N005 Chemistry and Chemical Engineering. N.M.R. Data Analysis. This research problem is concerned with the correlation of the chemical shifts in the proton magnetic resonance of quaternary ammonium salts to the salt concentrations. The IBM 7094 may be used to provide the correlation of the experimental data to a computable function, $f(x,y,p,q)$ obtained from theory. Given are: a computable function, $f(x,y,p,q)$ of four real variables, real-valued in the region of interest; and a set $\left[(x_r,y_r)\right]_{r=1,\ldots n}$ of (experimentally determined) pairs of real numbers, p_1,p_2,q_1,q_2 specifying a rectangle $p_1 \leq p \leq p_2$, $q_1 \leq q \leq q_2$ in the p,q-plane, and two real parameters Δp and Δq.

Real valued functions $\epsilon(p,q)$ and $m(p,q)$ are defined by the condition that, for each point in the rectangle of interest,

$$\sum_{r=1}^{n} \left[a_2 x_r^2 + a_1 x_r - f(x_r, y_r, p,q) \right]^2$$

assumes its minimum when $a_2 = \epsilon(p,q)$, $a_1 = m(p,q)$

What is desired is the locus in the p,q-plane of the points at which $\epsilon(p,q) = 0$, or, rather the intersection of this locus with the rectangle $p_1 \leq p \leq p_2$, $q_1 \leq q \leq q_2$.

The method is straight forward: on each of the lines $p = p_1 + i\Delta p$ $(i = 0,1,2,\ldots.)$ the program searches for the zeros of $\epsilon(p,q)$ in the interval $q_1 \leq q \leq q_2$, printing the desired information at each one.

644-3N006 Theoretical and Applied Mechanics. Shell Deflections. The first step in the solution of the shell deflection problem will be to determine various constant coefficients which represent the geometry of the specific shell. These will be found using the determinant calculation subroutine.

With the above coefficients used as the coefficients of the ifferential shell equations, assumptions for the solution of the equations will be ade which will result in a set of N simultaneous real linear equations in N unknowns.

Now using the simultaneous linear equations subroutine these unknowns ill be determined.

The deflections will then be calculated by the summation of three eries.

45-3N008 Theoretical and Applied Mechanics. Thermal Stress in a Conic Shell. his thesis problem consists of solving for the stress resultants in a conical shell hat is suddenly submerged into a fluid at a different temperature.

The computer will be used to sum the series of characteristic nctions which represent the thermal portion of the stress resultants for various lues of time and boundary conditions. This series arises from the solution of the eat transfer equation, expanded in orthogonal functions, and then integrated in e shell equations.

6-3N009 Aeronautical and Astronautical Engineering. Skin-Stiffener Panels. e method of the transfer matrix is employed to obtain the natural frequencies of array of skin panels which are continuous over supporting stringers. The ringer spacing may be non-uniform and individual panels may be different one from e other. The determination of mode shape of vibration corresponding to each tural frequency is also discussed. To account for the effect of curvature a eory is advanced in which the mid-surface of each panel is considered inextensional the circumferential direction and the shear deformation in the mid-surface is sumed negligible.

The numerical solution to this problem involves a trial-and-error heme to find the eigenvalues in the product of a long chain of matrices.

7-3N010 Education. Factor Analytic Methods. This research project is ncerned with developing new techniques in factor analysis. In particular, methods determining a common factor space and finding a vector basis for this space will explored. Mathematically, these procedures require extensive matrix operations, th emphasis on methods for solving the algebraic eigenproblem.

648-3N011 State Water Survey. Electrical Variables Flight Analysis. A C-45H aircraft has been flown during the summer of 1963 to obtain measurements of some of the electrical properties of the atmosphere. These measurements include vertical and horizontal components of potential gradient, conductivity, space charge, aircraft altitude, pitch and roll, temperature, and humidity. These variables were recorded on a 20 channel recorder. The record has been read by a Benson-Lehner chart reader and the information entered into cards. This data requires processing to obtain the values of the variables. The temperature must be corrected for the change in air speed and the altitude of the aircraft. The electrical variables all have nonlinear calibrations which must be applied.

649-3N012 Agricultural Economics. Demand for Limestone. Multiple regressions will be used to estimate the influence of selected factors (price, time, income, and subsidy) on the purchase of agricultural limestone in Illinois. Separate regression will be obtained for various segaments of the market.

650-3N013 Chemistry and Chemical Engineering. Transport and Flow Behind Solid Bodies. The over-all objective of this research program is to investigate mass transfer across a freshly formed interface that is being accelerated. Of particular interest is the effect of acceleration on the total transfer. Paramount to the actual study of the mass transfer problem is a study of the velocity field on either side of the interface. The IBM 7094 is being employed to obtain numerical solutions to the finite-difference form of the laminar boundary-layer fluid flow equations and correspondingly, the solutions of the diffusion equations for mass transfer.

651-3N014 Electrical Engineering. Satellite Ephemeris. The problem is that of calculating a satellite ephemeris given certain anomalistic elements and times of passage overhead. This is done by a Fortran program supplied by the National Bureau of Standards.

A sub-problem associated with the satellite ephemeris is that of using the results of the main program in the calculation of the earth's magnetic field at a subsatellite point of interest. This is done by use of associated Legendre polynomials in the sub-program. The result is then useful output for direct claculation, from Faraday rotation data, of the columnar electron content of the earth's ionosphere.

2-3N015 Psychology. Proximities Analysis. Given a set of proximity measures rank order the problem is to write a program to: compute a monotonic ansformation of these proximities that will recover the latent spacial structure the original data, then determine the minimum number of dimensions of the clidian Space required such that the distances in the space are monotonically lated to the initially given proximities, and finally determine an actual set orthogonal coordinates for the points in this minimum space.

When the program is completed it will be used to analyze several ts of proximity measures.

3-3N016 Digital Computer Laboratory. Tunnel Diode Circuits. The computer ll be used to evaluate the impedances of certain strip transmission lines. High equency response of these lines terminated in several types of tunnel diode rcuits will be computed.

-3N018 Aeronautical and Astronautical Engineering. Free Vibration of iffened Panels. The determination of the natural frequency, ω, and the rmal modes for a row of skin-stringer panels is the object of the program. The rmulation of the problem employes the theory of the "matrix of transmission". splacements, W, slopes, φ, moments, M, and shears, Q, are the unknowns of the oblem. With transfer matrices written for each field of the stiffened panel it possible by successive multiplication to transfer the vector quantities at one int in the panel to that at another. Including the actual boundary conditions of ase leads to an equation for the natural frequency eigenvalues. If T, is the nsfer matrix from one boundary condition to another then if the boundary nditions are free-free,

$$\begin{Bmatrix} W \\ \varphi \\ 0 \\ 0 \end{Bmatrix} = \begin{bmatrix} T \end{bmatrix} \begin{Bmatrix} W \\ \varphi \\ 0 \\ 0 \end{Bmatrix}$$

eigenvalue is obtained from the condition that

$$\begin{Bmatrix} 0 \\ 0 \end{Bmatrix} = \begin{bmatrix} T_{31} & T_{32} \\ T_{41} & T_{42} \end{bmatrix} \begin{Bmatrix} W \\ \varphi \end{Bmatrix}$$

t vanish. Thus

$$\Delta \equiv \begin{vmatrix} T_{31} & T_{32} \\ T_{41} & T_{42} \end{vmatrix} = 0$$

program calculates the values of the T matrix elements which are highly nscendental and then employes Newton's method to converge on the first three envalues satisfying the last equation.

655-3N020 Civil Engineering. Celestial Direction. With increased demands for extreme accuracy in directional orientation of modern structures comes an increased demand for the investigation of random and systematic errors involved in the accomplishment of this directional orientation. The usual method requires that a direction be determined by celestial observations. The effects of pointing, gravity anomalies, time determination, eccentricity of instrument, collimation, trunion inclination, refracion, position, solar radiation, and astronomic phenomena are, relatively speaking, uncertain at best. The purpose of this research project will be to study some of these effects by an analysis of many observations of the direction of a line and the conditions under which the observations were made.

656-3N019 Chemistry and Chemical Engineering. Combustion Instability. This study will include an analysis of combustion and flame stability, including oscillatory behavior and blowout phenomena. It is proposed to study the problem by means of a transient analysis. The IBM 7094 will be employed to generate eigenvalues of the linearized transient equations and to obtain complete solutions to the nonlinear partial differential transient equations for some combustion models.

657-3N022 Political Science. The Legal Process in a Behavioral Context. This project will involve a series of research problems dealing with a variety of different aspects of the legal process in a behavioral context. An attempt will be made to determine the role of various elements in producing various legal policies. The elements will include legal norms, non-legal norms, evidentiary facts, non-evidentiary facts, characteristics of the decision-makers, and interaction between the decision makers. An attempt will also be made to determine the effects of various legal policies (in combination with various natural and social facilitating and inhibiting factors) on the behavior and attitudes of various policy appliers and policy recipients.

The data include systematic content analyses of court cases and statutes, information obtained from biographical directories and gross statistics, responses to mailed questionnaires, and miscellaneous coded data from periodicals, treatises, prior computer runs, foreign materials, historical materials, interviews, and other sources.

The 7094 computer will be used to calculate frequency distributions, cross tabulations, chi squares, correlations, and regressions.

58-3N023 Education. Factor Analytical Study of Grades and Test Scores of ighly Able 8th Graders. The data consists of 4 grades, 4 mental ability test cores, and 8 achievement test socres for a total of 16 variables for each of 7 children. The problem is to do an iterative alpha factor analysis of the ata. It is to serve no other purpose than to constitute a term project for a ourse in multivariate analysis. To be included in the analytical method is a arimax rotation solution.

59-3N025 Chemistry and Chemical Engineering. Molecular Orbitals. The nvestigation of the effects of pi-interacting substituents on donor properties nd nuclear magnetic resonance spectra of carbonyl compounds is helped by xtended Hückel-theory calculations for the sigma-bonding system as well as the i-bonding system. This program sets up and solves the secular equation $|H-ES|=0$ y standard methods.

60-3N029 Mechanical Engineering. Hydrodynamic Gear Lubrication. In this nvestigation the pressure distribution and shear stresses in the oil films eparating gear teeth are computed. From these values the load capacity and riction losses are determined. In particular the effect of gear geometry on oad capacity and friction loss for given minimum film thicknesses will be tudied.

For each gear geometry and minimum film thickness quasi-steady tate solutions of instantaneous oil film thickness and friction losses will be ound at regularly spaced intervals in the angle of action. At each of these ositions (in the angle of action) an iteration procedure will be used on the omputer to find the instantaneous film thickness such that all films between the eeth engaged will support a total load that will result in a particular minimum lm thickness during the cycle of film thickness variation.

Distances between the gear teeth will be found from involute quations using the Newton-Raphson Method. Numerical integrations to first obtain e pressure in the film and then to integrate the pressures and shear stress in the l films to obtain the torques on the gears will be performed using trapezoidal tegration. The dissipation function will also be integrated over the volumne of the lms using the trapezoidal rule to obtain the losses. The instantaneous oil film icknesses for equilibrium will be established using an interval-halving integration utine.

661-3N031 Industrial Engineering. Tool Design. The characteristics of a material to be machined are input. Design the optimum tool (angles) using simple algebraic equations and material constants. Having designed the optimum angles, determine if such a tool exists commercially by table lookup. If the tool can not be purchased, complete the remainder of its design (shank dimensions, etc). Thus having determined a tool to be used, determine optimum feeds, speeds, coolants, etc, for the machines available in a given shop. The above criteria will be selected for minimum cost or maximum output. Information output will be commercial or special design tool specifications, speeds, feeds, coolants, machine to be used.

662-3N032 Physics. Conductivity in Superconducting Lead. The calculation of conductivity in superconducting lead can be carried out by using the following formulae

$$\sigma_s = (\text{conductivity}) = \sigma_1 + i\,\sigma_2$$

$$\sigma_n = (\text{conductivity in normal state})$$

$$\frac{\sigma_1}{\sigma_n} = \frac{1}{\gamma_m}\int_0^{\gamma_m} d\gamma \left[g(\gamma)\,g(\gamma') - h(\gamma)\,h(\gamma')\right] \quad \gamma' = \gamma + \gamma_m$$

where $g(\gamma)$ = density of states

$$= \mathrm{Re}\left(\frac{\gamma + \Delta_o}{\left[(\gamma + \Delta_o)^2 - \Delta^2(\gamma)\right]^{1/2}}\right)$$

$$h(\gamma) = \mathrm{Re}\left(\frac{\Delta(\gamma)}{\left[(\gamma + \Delta_o)^2 - \Delta^2(\gamma)\right]^{1/2}}\right)$$

$$\Delta(\gamma) = \Delta_1(\gamma) + i\,\Delta_2(\gamma)$$

$\dfrac{\sigma_2}{\sigma_n}$ can be calculated by using the Kramer-Kronig formula.

563-3N033 Mechanical Engineering. Two phase flow over a rotating Disk. The velocity, temperature, and concentration field of a rotating disk in two-phase flow-solid particles and gas - are to be studied. Consideration is given to the possible velocity slip and temperature slip between the two phases. Solutions of these simultaneous equations which govern the hydrodynamic (boundary layer theory approximation) energy transfer must satisfy certain boundary conditions. The governing equations are non-linear ordinary differential equations. The Runge-Kutta-Gill method will be used to solve these equations numerically.

564-3N034 Zoology. Responses to large and small opposite sex. Responses to large and small fish of opposite sex will be studied. A male cichlid fish is placed in an aquarium having a compartment at each end. In one compartment is a female slightly larger than he, in the other a female slightly smaller than he. The reciprocal experiment, female in the middle with a large and small male, is also done.

The objective is to determine the effect of large and of small sexual partners on the expression of 9 motor patterns seen during courtship, and on the distribution of time and number of choices.

The computer analysis is aimed at two prime objectives. One would be to evaluate the errors due to such variables as day of experiment and individual fish, and to assess the validity of the differences found in the variables measured. The second objective would be to explore by means of regressions the relationship between the dependent and independent variables. In particular what is the appropriate measure of size (length, depth, weight), and what is the most meaningful size comparison between the three animals?

5-3N035 Chemistry and Chemical Engineering. Enthalpies. This thesis research is concerned with hydrogen bond interactions of somewhat acidic protons with a wide range of Lewis bases. Enthalpies are obtained by calorimetric measurements in "non-solvating" solvents. Owing to the existence of competing equilibria, calculation of the desired hydrogen bond enthalpies from the experimentally determined energies is quite laborious.

The computer is used to solve for equilibrium concentrations of the various species and, from changes in these entities, the desired enthalpies. Specifically, cubic equations are solved and changes in these solutions with experimental parameters are related to the desired quantity.

666-3N037 Ceramic Engineering. Crystal Growth in Glass. A portion of this study of the nucleation and crystal growth in glass systems involves the experimental determination of crystal growth rates at various temperatures. An equation, derived from reaction rate theory, describes the temperature dependence of the growth rate in terms of five theoretically defined parameters. To obtain numerical values for these parameters, it is necessary to compare the equation to the experimentally determined growth rate data by treating these parameters as emperical constants. This latter process involves the use of the computer in solving five non-linear simultaneous equations.

667-3N038 Mechanical Engineering. Drag Reduction by Combustion. The problem is to investigate the supersonic combustion of hydrogen in the wake of a two-dimensional blunt based body with special emphasis on base drag reduction. In the theoretical solution to this problem there are a series of functions that need to be integrated by numerical means for various flow conditions and reaction rates. In addition the values of certain integrals are to be matched to find the limits of integration. The parabolic rule of integration will probably be used.

668-3N039 Mechanical Engineering. Verification of Burnett Equations. An experimental investigation is in progress to verify the Burnett Equations associated with rarefied gas dynamics. The IBM 7094 will be used to solve the differential equations involved in the theory, also to reduce the experimental data, and compile the necessary parameters to relate experiment and theory.

During the month of November, 7 Instructional problem specifications ere submitted to the IBM 7094.

94-3Ø062 Civil Engineering 391. Problem 3. Design of a Cover Plated Beam. he beam consists of a rolled section with symmetrical cover plates. The loading onsists of two equal loads P spaced a distance D apart. The dimensions and section roperties of the rolled beam and the allowable stresses are specified by the nput.

Draw a flow diagram and write a Fortran program to design the beam. he program is to work as follows:

1. From a load card, identified by the word "LØAD␣␣" in cc. 1-6, ead a load identification (Format A6), P (kips), D (ft), SPAN (ft), and N. Compute d store N ordinates of the curve of maximum moments at N points X_1, X_2, ..., , ... X_N, where,

$$X_i = \frac{i * SPAN}{2 * N}$$

cause of symmetry, only half of the curve has to be generated. The wheel spacing y be such that, for certain or all X_i's, only one load will fit on the span. The ximum moment ordinate must also be computed. For this problem, it can be assumed at the max. moment occurs at one of the X_i's, but not necessarily at midspan.

2. From a beam card, identified by the word BEAM␣␣ in cc. 1-6, ad the beam designation (Format A6), section modulus (in^3), depth (in), moment of ertia (in^4), cover plate width (in), max. coverplate thickness (in), allowable stress midspan (k/in^2), and allowable stress at the cover plate cutoff (k/in^2), then oceed as follows:

a) If beam alone is satisfactory, set T = COVER = 0.

b) If beam is not satisfactory, set cover plate thickness to 3/8" first cycle, and increase by 1/16" until a satisfactory cover plate is found. mpute the required cover plate length by examining successive moment ordinates and mparing the required section modulus to that provided by the beam alone. The cover .te cutoff can be assumed to be at the last X_i for which the beam alone is ;isfactory.

c) If the required cover plate thickness exceeds TMAX, print a signal message.

The program is to handle any arbitrary sequence of load and beam cards, except that the first card must be a load card. Output for each load and beam combination is to consist of:

Load identification
Beam designation
Section modulus required (in^3)
Section modulus provided (in^3)
Cover plate thickness (in)
Cover plate length (ft.)

I95-3N007 Industrial Engineering 283. Problem 3. Critical Path Programming. This problem will introduce the students to the use of networks. Each student will make up and solve his own problem using the standard library routine HO-UOI-CPP1-50-FR.

I96-3N021 Aeronautical and Astronautical Engineering 211. Problem 1. Aerodynamic Force on a Streamline. The student is given a stream function ψ(x, y, m) for an incompressible flow. A program for calculating over an appropriate grid (to use in plotting streamlines) and for determining the net aerodynamic force on a pair of streamlines is to be written.

I97-3N024 Mechanical Engineering 221. Problem 2. Slider Crank. The problem is to calculate the displacement, velocity, and acceleration of the piston of a slider crank. Standard library routines will be used.

I98-3N026 Theoretical and Applied Mechanics. Problem 1. Stress Analysis. The problem involves stress analysis of the stress around a solid cylinder placed in a hole in a plate.

I99-3N030 General Engineering 288. Problem 1. Railroad Communications Network. Voice and data requirements which are known are to be handled by commercial private long distance line, telpac, teletype and data transmission lines. Bell Laboratories has indicated that no efficient algorithm exists for the solution of this scheduling problem. The students have the responsibility of devising their own algorithms which will lead to an acceptable solution, i.e. to a least cost communication network.

I100-3N036 Mechanical Engineering 342. Problem 2. Cam Synthesis. The cam profile of a radial follower roller cam is to be calculated to conform with specified limits on velocities and accelerations.

Information on the utilization and reliability of the IBM 1401's and IBM 7094 for the month of November, 1963 is given in the tables below.

TABLE I - IBM 1401-I

Summary of Use

November, 1963

Scheduled Engineering	6:40
Unscheduled Engineering	10:45
Maintenance	10:07
7094 Preparation	320:00
Listing	8:06
Monthly Report Listing	3:53
Tape Dump	6:04
Code Check	6:05
Scanning Measuring Projector	9:25
Reproduction	7:02
Tape Test	:30
Tape Copy	1:51
CDC Preparation	1:30
Idle	116:43
	508:41

TABLE II - IBM 1401-I

Summary of Machine Errors

November, 1963

1401 Main Frame and Storage	1
1402 Read-Punch	5
1403 Printer	1
729 V Tape Units	1
	8

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAINTENANCE	IDLE	TOTAL RUNNING TIME	FAILURES	IBM 1401-I DAILY DISTRIBUTION TIME
11/1/63	19:16			:15	4:29	24:00	0	
11/2/63	1:30				6:30	8:00	0	
11/4/63	6:00	2:20			7:40	16:00	0	
11/5/63	20:10				3:50	24:00	0	
11/6/63	18:12	:25	1:50	:20	3:13	24:00	1	(1) Installation of new motor on tape unit A to fix backspacing problem when using CHAØS routine. Trouble first appeared last month.
11/7/63	15:18		3:35		5:07	24:00	0	
11/8/63	19:00		2:10		2:50	24:00	1	(1) Brushes on read side of 1402 damaged; replaced by engineer.
11/9/63	5:45				2:15	8:00	0	
11/10/63	2:36					2:36	1	(1) Random punch errors; trouble disappeared.
11/11/63	12:48			:10	3:02	16:00	0	
11/12/63	21:32			:35	1:53	24:00	1	(1) 1402 does not stop on reader errors. Trouble did not reoccur.
11/13/63	22:27			:35	:58	24:00	0	
11/14/63	17:07			:25	6:28	24:00	0	
11/15/63	21:51			:20	1:49	24:00	0	
11/16/63	9:40			:15	11:45	21:40	0	
11/18/63	12:20	1:10		:15	2:15	16:00	0	
11/19/63	19:22		:10	2:35	1:53	24:00	1	(1) Print ready light burned out. Replaced.
11/20/63	17:01			:55	6:04	24:00	0	
11/21/63	18:24			:55	4:41	24:00	1	(1) Card jam in punch-side of 1402. Removed by engineer.
11/22/63	18:30			:40	4:50	24:00	0	
11/23/63	7:45				12:35	20:20	0	
11/24/63	1:40					1:40	0	
11/26/63	12:10	2:45		:40	:25	16:00	0	
11/27/63	14:50			1:12	7:58	24:00	1	(1) 1402 feeding object cards into N/P hopper. Trouble disappeared.
11/28/63					8:00	8:00	0	
11/29/63	13:00		3:00			16:00	1	(1) Information printed not correct. Machine checked but reason not found. Trouble disappeared.
11/30/63	16:12				6:13	22:25	0	
Totals	364:26	6:40	10:45	10:07	116:43	508:41	8	

TABLE I - IBM 1401-II

Summary of Use

November, 1963

Scheduled Engineering	2:25
Unscheduled Engineering	3:41
Maintenance	8:34
7094 Preparation	380:26
Listing	9:00
Monthly Report Listing	2:14
Tape Dump	8:52
Code Check	4:24
Scanning Measuring Projector	21:03
Reproduction	7:03
Tape Test	3:15
CDC Preparation	:15
Idle	79:44
	530:56

TABLE II - IBM 1401-II

Summary of Machine Errors

November, 1963

1401 Main Frame and Storage	1
1402 Read-Punch	2
1403 Printer	4
729 V Tape Units	0
	7

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAINTENANCE	IDLE	TOTAL RUNNING TIME	FAILURES	IBM 1401-II DAILY DISTRIBUTION TIME
11/1/63	23:20			:20	:20	24:00	0	
11/2/63	9:20				:40	10:00	0	
11/3/63	3:48					3:48	0	
11/4/63	23:45				:15	24:00	0	
11/5/63	22:18				1:42	24:00	0	
11/6/63	22:15	:25	:25	:25	:30	24:00	1	(1) Process error during printing, did not reoccur.
11/7/63	17:34				6:26	24:00	0	
11/8/63	21:10				2:50	24:00	1	(1) Card jam in punch side of 1402. Removed.
11/9/63	11:30			:15	1:35	13:20	1	(1) Carriage restore on 1403 failed, trouble disappeared.
11/10/63	4:43					4:43	0	
11/11/63	14:31		:11		1:18	16:00	1	(1) Fuse blew on reader; replaced by engineer.
11/12/63	22:10			1:20	:30	24:00	0	
11/13/63	21:21			:15	2:24	24:00	0	
11/14/63	20:35				3:25	24:00	0	
11/15/63	18:48			:30	4:42	24:00	2	(1) Ribbon winding to one side. Engineer checked. Trouble disappeared. (2) Sync check errors on 1403. Trouble disappeared.
11/16/63	16:15				5:00	21:15	0	
11/17/63	4:00					4:00	0	
11/18/63	12:52	2:00			1:08	16:00	0	
11/19/63	21:15				2:45	24:00	0	
11/20/63	16:30		3:05	:35	3:50	24:00	1	(1) Hammer in position 75 on 1403 failed. Repaired magnet coil.
11/21/63	23:15			:30	:15	24:00	0	
11/22/63	16:17			:45	6:58	24:00	0	
11/23/63	13:00				7:00	20:00	0	
11/24/63	1:15					1:15	0	
11/26/63	12:03			1:58	1:59	16:00	0	
11/27/63	16:52			1:11	5:57	24:00	0	
11/28/63	8:00					8:00	0	
11/29/63	15:00			:30	:30	16:00	0	
11/30/63	2:50				17:45	20:35	0	
Totals	436:32	2:25	3:41	8:34	79:44	530:56	7	

TABLE I - IBM 7094

Summary of Use

November, 1963

Scheduled Engineering	27:58
Unscheduled Engineering	18:38
Air Conditioning	4:30
System Updating	3:19
Production	514:23
Miscellaneous (tape rewind, tape mounting both system and user, rerun of failing problems, tape skipping, destruction of clock reading)	127:12
	696:00

TABLE II - IBM 7094

Summary of Machine Errors

November, 1963

Central Processor	6
Multiplexor	1
Channel A	1
Channel B	1
729 VI Tape Units	15
	24

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR-CONDI-TIONING	OPERATOR MANI-PULATION	TOTAL RUNNING TIME	FAIL-URE	DAILY DISTRIBUTION TIME
11/1/63	16:04	1:03			6:53	24:00	1	(1) 7094 halts on MPY orders while in automatic. Did not reoccur.
11/2/63	20:17		:15	1:15	2:13	24:00	2	(1) Air conditioning failed causing 7109 to shut off. Temperature came back to normal. (2) Unexplained trouble in updating MTI. Suspect Channel A trouble.
11/3/63	24:00					24:00	0	
11/4/63	18:47	2:12	:12		2:49	24:00	2	(1) Non-consistent I/Ø errors on Channel B. Reason unknown (2) Errors in translation. Trouble disappeared. Checking 7631 on-line.
11/5/63	17:59	1:25	:40		3:56	24:00	0	
11/6/63	17:30	:47			5:43	24:00	0	
11/7/63	12:59	1:38	1:18	3:15	4:50	24:00	1	(1) Errors resulting from power-off status because of air-conditioning failures. Several bad cards replaced. Checking 7631 on-line.
11/8/63	16:34	:45	1:14		5:27	24:00	0	
11/9/63	22:01				1:59	24:00	0	
11/10/63	17:51				6:09	24:00	1	(1) Excessive machine errors in Fortran. Tapes changed and trouble disappeared.
11/11/63	17:46	1:45	:02		4:27	24:00	1	(1) Excessive machine errors in Fortran. Suspected Floating Trap errors. 9M51 run but no error found.
11/12/63	16:49		:30		6:14	24:00	3	(1) Excessive tape errors on units W and V. Units cleaned and trouble disappeared. (2) Unit W taken off line because of write failures. (3) Suspected Floating Point add errors. Diagnostic run but no error found.
11/13/63	16:14	1:40			6:06	24:00	0	
11/14/63	18:17				5:43	24:00	2	(1 and 2) Tape Unit Y piling tape in vacuum tubes. Tape unit adjusted working on unit V.
11/15/63	14:23	2:25	1:50		5:22	24:00	0	
11/16/63	19:11				4:49	24:00	1	(1) Excessive tape errors on Unit V. Unit cleaned and trouble disappeared
11/17/63	24:00					24:00	0	

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR-CONDITIONING	OPERATOR MANI-PULATION	TOTAL RUNNING TIME	FAIL-URE	DAILY DISTRIBUTION TIME
11/18/63	16:10	2:20			5:30	24:00	1	(1) Excessive tape errors on Unit Q. Units cleaned and trouble disappeared.
11/19/63	13:35	2:10	:43		7:32	24:00	1	(1) MTI and MTII were worn out causing random machine errors. Tapes were re-edited and trouble disappeared
11/20/63	15:56	2:10			5:54	24:00	1	(1) Tape Unit "U" does not recognize reflective spots. Engineer adjusted write skew and read amplifier.
11/21/63	13:48	2:05	:04		8:03	24:00	2	(1) Excessive errors in Fortran caused by worn out MTI. Tape was replaced. (2) Tape Unit V withdrawn from service because of write failures. Tape Unit V taken off-line.
11/22/63	14:32	1:38	3:26		4:24	24:00	0	
11/23/63	21:29				2:31	24:00	1	(1) Excessive errors in Fortran Suspected bad tape on Unit V.
11/24/63	24:00					24:00	0	
11/25/63	8:00					8:00	0	
11/26/63	7:52	2:00	4:00		2:08	16:00	2	(1) Failures resulting from turning power-off on 11/25/63. Two cards replaced in 7110. broken wire replaced in 7109. (2) Tape unit V taken off-line because of write errors
11/27/63	12:06	1:55	:50		9:09	24:00	2	(1) Errors in Fortran. Units cleaned and trouble disappeared. (2) No compilation or execution. Dropping a bit in channel address Counter or Command Counter. Trouble disappeared. Power turned off and would not come on because Main Power Generator was not reset. Generator reset and power came on.
11/28/63	19:25		2:30		2:05	24:00		Tape unit V being tested on-line.
11/29/63	18:41		1:04		4:15	24:00	0	
11/30/63	21:26				2:34	24:00	0	
	517:42	27:58	18:38	4:30	127:12	696:00	24	

DEPARTMENT	Number of Runs				Number of Problem Specifications				Total Time Used			
	Class	Research	Non System	Total Number of Runs	Class	Research	Non System	Total Number Prob. Specs.	Class	Research	Non System	Total Time Used
Aeronautical and Astronautical Engineering	3	139		142	1	7		8	:05	2:31		2:36
Agricultural Engineering		138		138		4		4		4:55		4:55
Agricultural Economics		127	14	141		9	3	12		2:07	2:58	5:05
Agricultural Education		5		5		1		1		:15		:15
Agronomy	226	157		383	1	10		11	3:13	1:33		4:46
Animal Science		13		13		4		4		:19		:19
Astronomy		45		45		4		4		:57		:57
Bureau of Economic and Business Research		116		116		4		4		1:05		1:05
Biophysics		2		2		1		1		:16		:16
Civil Engineering	755	775		1530	9	30		39	6:34	27:13		33:47
Chemistry and Chemical Engineering	176	1087		1263	2	39		41	3:19	67:21		70:40
Children's Research Center		1		1		1		1		:01		:01
Center for Zoonoses Research		83		83		1		1		:50		:50
Digital Computer Laboratory	739	699	14	1452	2	23	3	28	5:56	25:34	5:09	36:39
Dairy Science		33		33		2		2		:46		:46
Economics	1	97		98	1	4		5	:05	3:18		3:23
Education		54		54		7		7		1:17		1:17
Educational Testing		8		8		1		1		:22		:22
Electrical Engineering	486	167		653	11	13		24	3:37	5:49		9:26
Forestry		9	2	11		1	1	2		1:04	:42	1:46
General Engineering		14		14		2		2		:16		:16
Business Administration, Graduate School	238	3		241	2	1		3	5:08	:01		5:09
Institute of Communications Research		35		35		1		1		:28		:28
Industrial Engineering	43			43	4			4	:12			:12
Institute of Government and Public Affairs		10		10		1		1		:24		:24
Instructional TV		59		59		3		3		2:12		2:12
Mathematics	2741	10		2751	2	3		5	18:41	:14		18:55
Mechanical Engineering	206	406		612	4	16		20	1:43	10:29		12:12
Mining, Metallurgy and Petroleum Engineering		8		8		3		3		:02		:02
Men's Residence Hall Association Pocket Club		5		5		1		1		:06		:06

DEPARTMENT	Number of Runs				Number of Problem Specifications				Total Time Used			
	Class	Research	Non System	Total Number of Runs	Class	Research	Non System	Total Number Prob. Specs.	Class	Research	Non System	Total Time Used
Nuclear Engineering	2	255		257	1	3		4	:01	8:45		8:46
Office of Instructional Research		30		30		1		1		:26		:26
Physical Education for Men and Graduate PE		2		2		1		1		:20		:20
Physics		1269	54	1323		33	2	35		49:05	193:30	242:35
Political Science		5		5		1		1		:13		:13
Psychology		416		416		31		31		21:12		21:12
Statistical Services Unit		444		444		1		1		12:00		12:00
State Water Survey		96		96		8		8		1:18		1:18
Theoretical and Applied Mechanics		190		190		11		11		5:52		5:52
Sub Total	5616	7012	84	12712	40	287	9	336	48:34	260:56	202:19	511:49
Instruction		294		294		1		1		2:34		2:34
Grand Totals	5616	7306	84	13006	40	288	9	337	48:34	263:30	202:19	514:23

PART VI

GENERAL LABORATORY INFORMATION

Colloquia

"The Scope of Computer Application in the U. K. Today and Tomorrow," by Mr. S. L. H. Clarke, Elliott Brothers, Borehamwood, England, November 4, 1963.

"The Executive Program for the SMP-The Scanning Measuring Projector, and On-Line Bubble Chamber Photograph Data Reduction Device," by Mr. John Munson, Lawrence Radiation Laboratory, University of California, Berkeley, California, November 5, 1963.

"A Digital Spark Chamber," by Mr. Michael Neumann, Computer Research Center, University of Chicago, Chicago, Illinois, November 11, 1963.

"Sets of Infinite Sequences and Their Representation by Automata," by Professor D. E. Muller, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, November 18, 1963.

Personnel

The number of people associated with the Laboratory in various capacities is given in the folllowing table:

	Full-time	Part-time	Full-time Equivalent
Faculty	15	1	15.5
Visiting Faculty	5	1	5.5
Research Associates	3	0	3.0
Graduate Research Assistants	3	49	27.17
Graduate Teaching Assistants		5	2.23
Professional Personnel	5	2	6.0
Administrative and Clerical	10	0	10.0
Other Nonacademic Personnel	47	74	81.1
TOTAL	88	132	150.5

The Computer Advisory Committee consists of Professors H. C. Brearley, J. R. Ehrman, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During November a total of 99 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	9	2
Medium Drawings	2	0
Small Drawings	16	1
Reports	47	3
Change Orders	1	8
Printed Circuits	0	4
Miscellaneous	4	2
TOTAL	79	20

(K. C. Law, P. Richardson)

Physics

DIGITAL COMPUTER LABORATORY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

TECHNICAL PROGRESS REPORT

PART I - HIGH-SPEED COMPUTER PROGRAM

PART II - ILLIAC II SYSTEM PROGRAMMING, MAINTENANCE AND OPERATION

PART III - CIRCUIT RESEARCH PROGRAM

PART IV - IBM 7094-1401 SYSTEM

PART V - GENERAL LABORATORY INFORMATION

DECEMBER 1963

PART I

HIGH-SPEED COMPUTER PROGRAM

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois.

1. New Construction-Electronic Shop

Transistor counts for assemblies completed during December are as follows:

	ILLIAC II	TOTAL
Etched cards new	648	1846
Etched card repairs	(23 cards)	(23 cards)
Etched card modification	(6 cards)	(6 cards)
Relay card modification		(53 cards)
Chassis dc checked	310	310
Chassis inspected	406	406
Chassis wired	406	406

In addition the following units were wired:

5 channel power regulators

7 channel dc turn-on modules

2 laboratory power supplies

(F. Serio)

2. New Construction - Mechanical Shop

The printed circuit facility processed the following during December:

	ILLIAC II	TOTAL
New layouts finished	2	7
Layouts revised	1	3
Proto-type boards wired	1	6
Complete boards (19 were single rush jobs)	119	150

The shop completed the following:

5 male regulator frames

5 female regulator frames

12 vertical voltage bus bars for PCB racks

1 main unit of a twin PCB rack

(T. E. Kerkering)

3. Component Testing

Acceptance tests have been run on 47,500 diodes, including about 32,000 1N995 and 15,000 TI55, and on approximately 1200 transistors of various types.

One thousand transistors of type 2N706A, accepted from a low bidder rather than the normal supplier, have been found sadly below standard. More than half of the units received do not meet the internal acceptance criteria normally used for this type.

Pedigrees on 204 N250 transistors were completed and are under test in flow gating chassis FB FR #9 and FT FR #3.

(B. M. Doden)

4. Delayed Control

A wiring error was found in Q7F affecting only NDV by -1 or VID when rounded to + 1. The faulty operation error occurred in D18 of the divide sequence when doing an $\overline{M}MsS$: the $\overline{m}_{-1}$ and $\overline{m}_o$ were reversed in going to t_{-1} and t_o. (Refer to drawing D-1522). A repeat of some of Jordan's calculations has shown them to be unaffected by this change.

(R. F. Kingsley)

5. Flow Gating

A. Spare Chassis

Spare flow gating chassis are proceeding as follows:

D999	#5	in wiring stage
D997	#9	ready for machine check
D993	#5	ready for machine check
D996	#9	operating in the machine

(H. E. Lopeman, L. L. Byers)

B. Flow Gating Bootstrap

In preparation for a new bootstrap using the fast registers, cabling to 17 of the 24 chassis is complete. The cabling makes available a twisted pair to each bit of registers 9, 8, 2, 3, 4, 5, 6, 7 of flow gating.

(H. E. Lopeman, L. L. Byers)

6. Interplay

A. Channel Numbering

Channel numbers have been reassigned as follows:

Channel Number	Device
2	1301
3	1301
4	1414
5	1414
6	1414
7	1414
14	1460
15	1401*
16	PAU
17	PAU
18	PAU
19	PAU

(S. P. Krabbe)

B. Multiple Block Transfers

It was decided not to expand the order code in order to execute multiple block transfers. Rather, the information specifying the number of blocks to be transfered will be sent to channels via the $\overline{SU}x$ lines (8 least significant bits of PID or POD) or perhaps via a special register.

Implementation of the multiple block transfer scheme has begun. The Interplay address register IAR has been modified and the logical design of the channel electronics required to transfer multiple blocks is complete.

---

* The 1401 (special register 30_8 and 35_8) is currently Channel 3.

7. IBM 1414 Interplay Channel

Block transfers are working properly, with a single-bit error rate of approximately 10^{-8}. Since these errors do not cause core parity errors, they are presumably errors in the 729 tape units or in the 1414 control. Each of the SSR-operations has been checked out and, individually, function properly. However, some sequences of SSR-operations cause program dependent race conditions; these are now under investigation.

(R. E. Willard)

The change from single conductor to twisted pair wiring is completed on the "A" racks of the 1414 Channel and drawings and wiring lists for this channel are currently up to date.

(H. E. Lopeman)

8. IBM 1301 Interplay Channel

The logical design for the Interplay Channel Control of the first IBM 1301 channel has begun. This channel is fixed on a 6-bit-per-character mode with 9* characters per 52-bit ILLIAC word. Typical ICC and character counter logics have been modified for this channel.

(Y. Yen)

9. Programmable Tape Switching

Final logic diagrams for the programmable tape switching facility are complete.

(D. Collins)

* The ninth character has four bits only.

10. Console

The console switches (SR06) have been replaced by buffered switches and the old SR06 has become $SR34_8$.

Following a final check of the console typewriter logic, wiring lists have been completed and all cards are on order. The wiring is 50 per cent complete.

(H. E. Lopeman, S. P. Krabbe and J. Bouknight)

PART II

ILLIAC II SYSTEM PROGRAMMING, MAINTENANCE AND OPERATION

This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois.

1. ILLIAC II FØRTRAN

The section of program that reads cards, decides on the statement type and converts all numbers and names into an internal representation, is working. Better than half of the work on the control transfer and input/output compilations is complete. An I/O package for FØRTRAN execution time has been written but not checked. Work on FØRTRAN is not being hurried at this time because it cannot be finally implemented until the new assembler and basic system are available. These are delayed somewhat by the attachment of magnetic tapes and the next 4096 words of core memory.

(C. W. Gear)

2. General Maintenance

A. Power Supply Margins

On December 10 a $\pm$ 12 per cent voltage (+25, -50) margin was done on regulators (9, 10, 13, 14, 16) R and (9, 10, 13, 14, 15, 16) F. These regulators control the voltages for Delayed Control, Advanced Control and Auxiliary Arithmetic units. The program (DAMN) continued to run successfully throughout the voltage changes.

Attempts to run voltage margins on the main arithmetic unit and flowgating give results that are confusing because the two areas share the same voltages. A versatile alternate supply is ready for use in isolating a single chassis for purposes of determining whether or not it would be worthwhile to supply the two areas separately.

(C. E. Carter)

B. Power Regulators

In file number 571 it was suggested that the replacement of transistor type 2N1146 with a type 2N1537 would reduce a major cause of machine failure. We are proceeding with this replacement but because of the nature of the equipment and its relation to the operating machine the job will take some time. During the month of December transistors were replaced in 5 regulators.

Machine Location	Regulator Removed Number	Regulator Installed Number
6R	21	21
9R	23	39
10R	29	41
13R	35	38
14R	18	42

(H. E. Lopeman, L. L. Byers)

C. Over/Under Voltage Detection System

All O/U sense signals of the main frame regulators were checked in mid-December resulting in the replacement in amplifier cards of 8 2N335 transistors by SM 1530 transistors.

(H. E. Lopeman, L. L. Byers)

3. Component Failure Log Summary

Components failed

Capacitors	1
Transistors	13

Components causing machine stoppage are indicated by use of an (*) with the log number. In summary, these are:

Capacitors	1
Transistors	5

(C. E. Carter)

COMPONENT FAILURES FOR THE MONTH DECEMBER, 1963 - SUMMARIZED JANUARY 2

COMPONENT	TYPE	LOG NO.	LOCATION	FAULT	REASON	COMMENT
Capacitor	.1 mfd at 75v	*20	Sec. J of A14R	Short	Spontaneous	
Transistors	S166	*15	Q8F-218	Open e-b		
	N-250		FGb997#5	Short e-c		
	N-250	*17	165-153	Low e-c,V		
	2N2080	*18	+25 Reg. 1414	Short	Induced by human error	Components not at fault
	2N2081	*19	-25 Reg. 1414	Short		
	2N335	21	NJE Reg. 5F -+ 6.8 amp	$\alpha < .90$		
	2N335	22	14F -+ 25 amp	$\alpha < .90$		
	2N335	23	16F -+ 6.8 amp	$\alpha < .90$		
	2N335	24	13R -+ 6.8 amp	$\alpha < .90$	Responsible for drift of o/u signal	Replaced by SM1530
	2N335	25	9R -+ 6.8 amp	$\alpha < .90$		
	2N335	26	2R -+ 6.8 amp	$\alpha < .90$		
	2N335	27	9F -+ 6.8 amp	$\alpha < .90$		
	2N335	28	14F -+ 6.8 amp	$\alpha < .90$		

4. Operations

A. Machine Use

Engineering		
General	109:23	
Drum	19:05	
1414	125:47	
Interplay	5:42	259:57
Engineering Tests		
ETR	:05	
ASMD	:05	
OLF	8:51	
Duplex Memory	:29	
DAMN	274:58	
BTC	4:37	289:05
Code Checking		82:53
Production		
Jordan	89:10	
Gear	:40	99:55
Bouknight	10:05	
Idle		11:05
Power Off		1:05
TOTAL HOURS IN OPERATION		744:00

B. Error Analysis

ILLIAC II		
Reader	1	
Punch	3	
Core Parity	4	
Main Frame Power Drop	9	
Arithmetic Failure	1	
Core Power Drop	2	
1401 Channel Error	2	22
1401 Equipment		
Card Reader	1	
1403 (Printer)	1	2
Unknown		4
TOTAL NUMBER OF ERRORS		28

(W. L. Huffman)

PART III

CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1. Summary

Sergio Ribeiro and Gabor Ujhelyi obtained a preliminary success in their efforts to use a gallium arsenide lamp--photodiode coupling system and a high-gain transistor amplifier. It was found possible to obtain a current amplification of about 2000 with a rise-time of less than 2 nsec. It should be emphasized that such an amplifier does not need any voltage swing because of the current generator characteristic of a photodiode and the (constant voltage) current control of the lamps. Louis Marthe has joined this group on a temporary basis.

Louis van Biljon has continued his theoretical and experimental microplasm work. His experiments are still plagued by the difficulty of synchronizing a sampling system with the more or less random microplasm pulses.

Henry Guckel and Stephen Nuspl have run some experiments on Goto pair bistable cells. Severe noise problems were encountered and it appears that right now the storage of information presents more problems than the logic.

2. Photo-coupled Circuits

Using the presently available noncoherent lamp diodes and photodiodes, the best current coupling ratio (output current of the photodiode over the input current to the lamp diode) was measured to be about 1 over 7000 at room temperature (See Figs. 1 and 2). Our general aim is of course to improve this coupling ratio and we are continuing our search for more efficient diode pairs. The main difficulty lies with the low photon generation efficiency of the lamp diode at room temperatures.

In an attempt to use commercially available devices (diodes), we tried to construct fast, high gain transistor current amplifiers. Since the dynamic impedance of the lamp diode is small (few ohms), it is theoretically possible to construct high gain current amplifiers with very short rise and

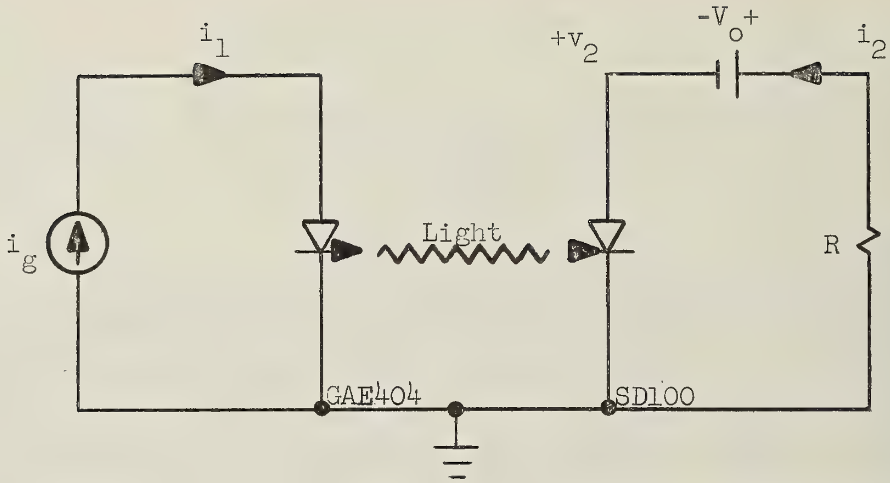


Figure 1. Circuit Diagram of Light Coupling Measurement

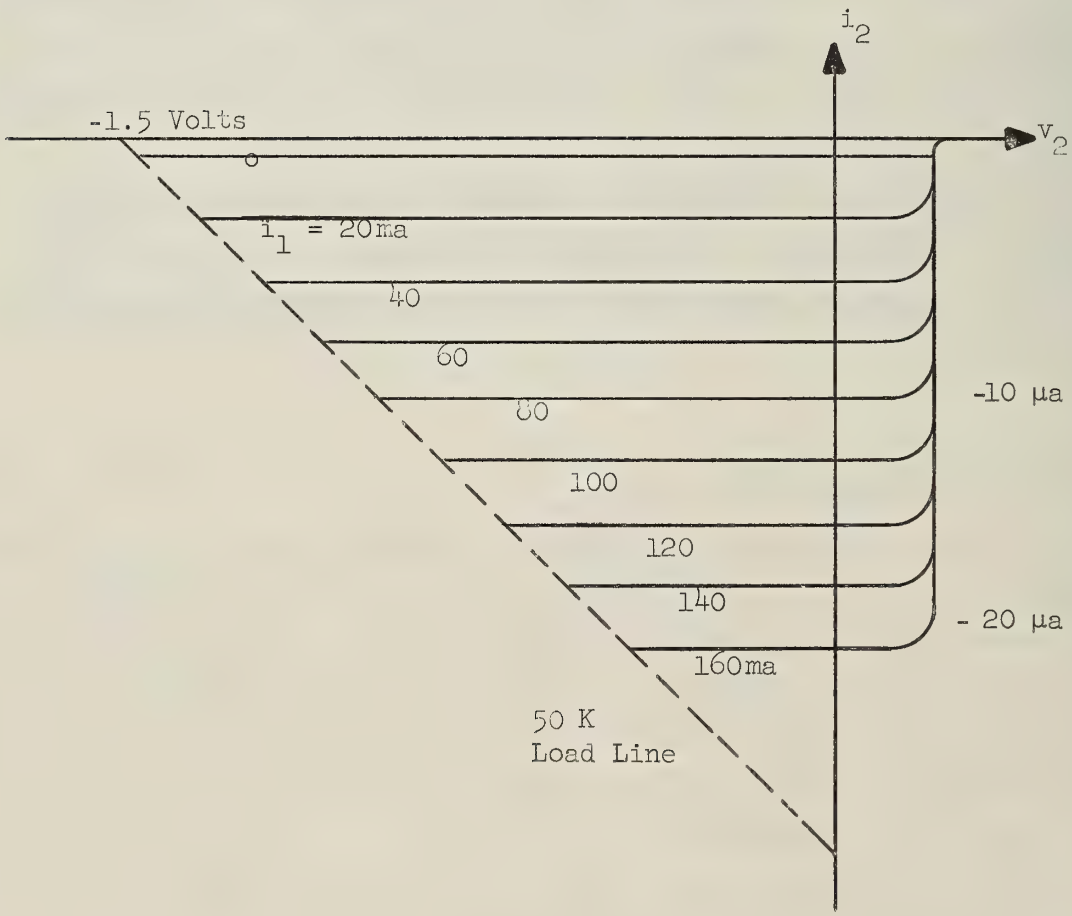


Figure 2. Coupling Characteristics of Circuit $^1/a$

fall times (in terms of transistor performance).

We have developed a two stage transistor amplifier whose current gain is above 1300 and with the following pulse response: for an input pulse of 0.5 nsec rise time, it has a delay of 1 nsec and a rise time of 1 nsec, thus reaching its ON level about 1.5 nsec after the input pulse does. This behavior is about the same when the input pulse is being turned OFF. See Figs. 3 and 4. Notice that the calculation of gain has been made from Fig. 4a ignoring overshoots, which can be eliminated.

The relatively low gain (considering that the product of the β's is more than 40,000) is due to the relatively high input impedance and the consequent loss of input current through the biasing resistors of the input stage. This must be improved since we need both a higher gain and a low input impedance to avoid a slow rise time of the photodiode output current.

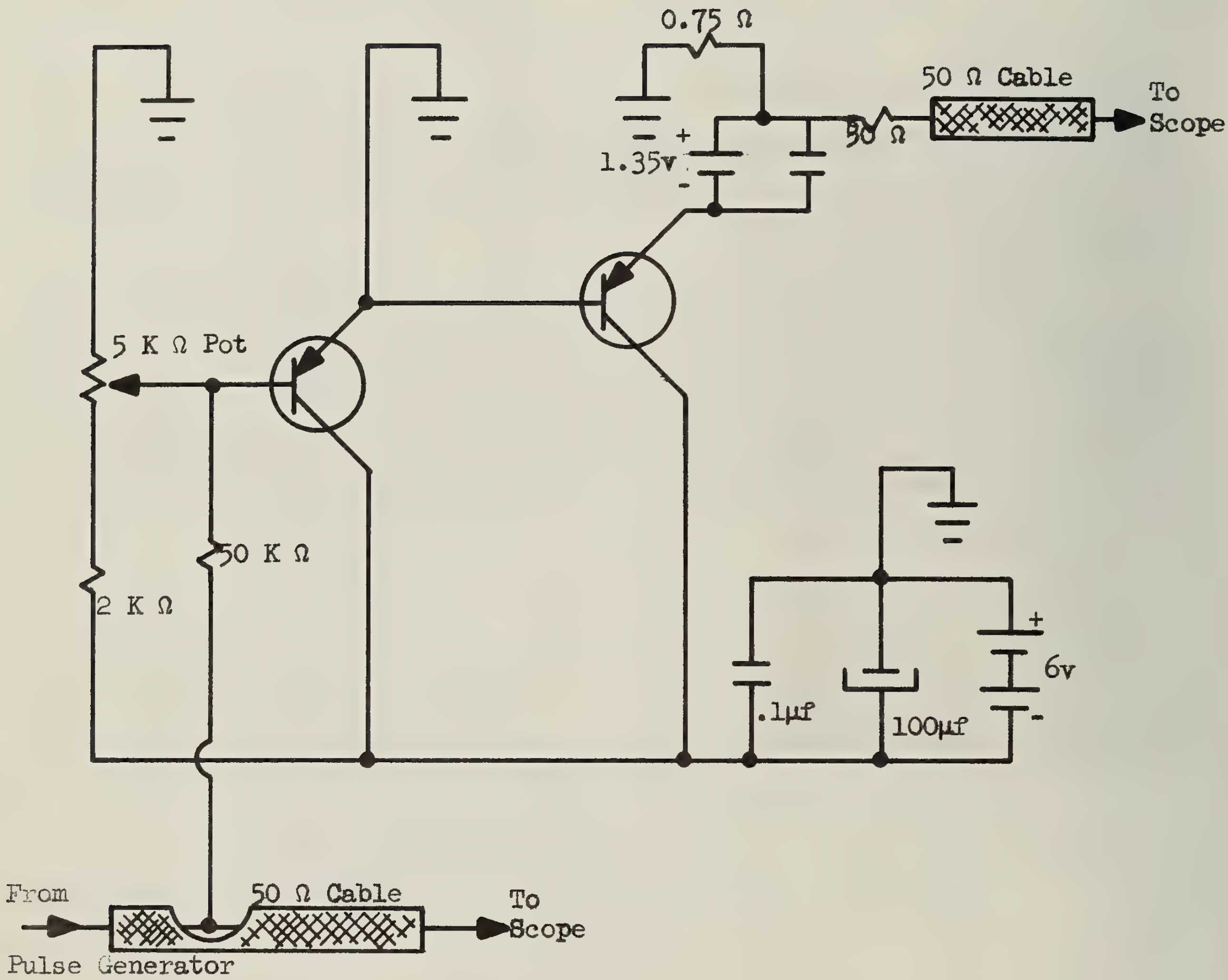
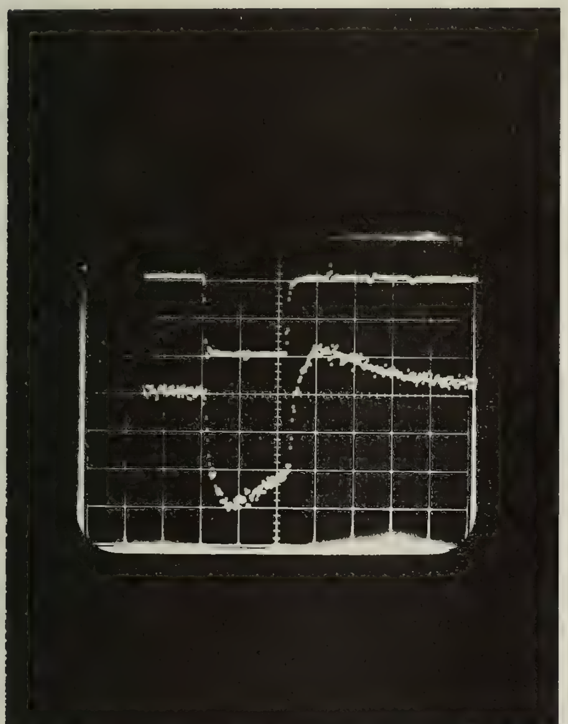
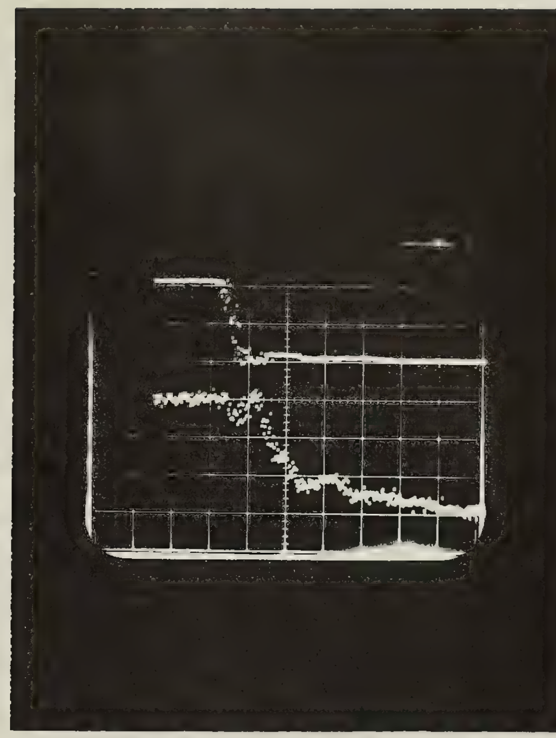


Figure 3. Experimental circuit for a fast high gain current amplifier. The constant voltage of the battery in the emitter circuit of the output stage simulates the useful portion of the gallium arsenide lamp-diode V-I Characteristic.





a. Overall View
Horizontal Scale: 10 nsec/div

b. Rise Time View
Horizontal Scale: 1 nsec/div

Figure 4. Input and Output Pulses
Vertical Scales: Input Pulse (up): 10 μa/div
Output Pulse (down): 13.3 ma/div

3. Microplasm Work

An analytic description of microplasma behavior is still being pursued, taking into account the lattice temperature as one of the most important parameters.

The purpose is to find a workable relation between applied field strength (in depletion region) and the time during which a discharge switches on and remains on.

It is considered that energy is gained from the field, lost to the lattice, and since the lattice temperature influences the mean free path length both rates of exchange of energy are influenced by the ruling temperature.

Both the time for a carrier to be accelerated to ionizing energies, as well as the time for the current pulse to remain on, are direct functions of the temperature, this temperature also being a function of the current itself via ohmic losses. Due to circuit resistance the accelerating field itself is determined by the current so that extinguishing of the discharge is accelerated both by increasing temperature and falling field strength.

These factors are being considered in a report now being prepared.

Some of the more difficult aspects of the analysis deals with accurate description of the temperature rise. If it is assumed that a normal microplasma current of 100μA is confined to the dimensions observed, say 1 micron cubed, while energy loss to the surroundings is neglected, the local temperature is found to rise about 1000° Centigrade. On the other hand, taking due consideration of thermal conduction and averaging over a long period of time, the temperature rise may be only about 20° Centigrade. The influence of traps also is leading to severe analytical difficulties, while also profoundly influencing the observed behavior of the junctions.

The most troublesome difficulty is that of spurious breakdown, caused by the appearance of a carrier capable of ionization.

If the spurious carriers are of thermal origin they may be eliminated by cooling the lattice so that only injected carriers or photons will produce breakdown. However, at low temperatures, the low concentration of free carriers leaves most traps unoccupied. These traps seem to leave an inherent random capture time and while they are active, spurious breakdowns

are bound to occur. The traps may be put out of operation by having them all filled, this being done by raising the ambient temperature so as to increase the concentration of free carriers. However, increasing the temperature, also increases the probability of thermal carrier generation, restoring the status quo. For reliable operation, traps will have to be eliminated and this is in the process of being done as shown by the production of microplasma diodes having even lower firing rates.

Oscillographic observation of microplasma breakdowns will now be continued as the Lumatron oscilloscope is back in commission.

4. Tunnel Diode Work

Report No. 157 has been prepared. It summarizes the work done in connection with strip line parameter calculations.

Experimental work on some bistable cells employing Goto pairs has been completed. These experiments were performed on high frequency lay-outs. Results are not encouraging. The cells can be set to the desired states if high enough drives are provided. However, re-setting to the zero voltage state occurred in a random fashion. This is thought to be due to noise and thermal changes, which act then as low level inputs, i.e., result in the unwanted zero voltage state. The long term stability of this type of circuit is thus poor.

Several new 1 ma diodes have been received. These are to be used as terminations in the intercoupled line amplifier. Measurements indicate that these units are improved versions of Micro State's previous diode. This presents additional stability problems, which are still being studied. Computer analysis is planned and in progress.

The Lumatron scope has been overhauled and re-calibrated. The sampling system is in working order.

PART IV

IBM 7094-1401 SYSTEM

(Supported in Part by the National Science Foundation under Grant No. NSF-GP-700)

NEW ROUTINES

N2-UOI-DYND-54-SR Dynamic Diagnostic Routine FØRTRAN or SCATRE. This routine allows the user to obtain a dump of machine registers and contents of a block of core storage, with control being returned to the user after the dump. Machine registers are available in two classes as indicated by a parameter I. Only registers of the first class are restored before returning to the user's program. Contents of core locations are available in several formats as indicated by a parameter M. (See detailed program description.)

(J. N. Lockhart)

During the month of December, 29 problem specifications were submitted to the IBM 7094.

669-3N040 Dairy Science. Generation of Normally Distributed Random Numbers. This problem concerns becoming acquainted with two subroutines and the programming associated with the generation of normally distributed randon numbers.

As soon as an understanding and adequate proficiency are gained, a research problem concerned with the generation of a simulated biological population, whose properties are known, will be undertaken and the estimation of the effects of specific selection criteria on that population. This procedure is referred to in some disciplines as a Monte Carlo study and is finding increased application in theoretical genetic and animal breeding studies, for example. Basically, the problem consists of the generation of normally distributed random numbers with a mean of zero and with a particular standard deviation(s), as specified by the programmer.

670-3N042 Physics. Formal Language. The computer will be used in the development of a formal language for the computer in the area of data processing. The study is from the rules of the grammer, and the computer will be used to check some but not all aspects of this. No attempt will be made to write a detailed program to parse and translate a subset of English into a set of symbols which could be used by a computer.

671-3N044 Agricultural Economics. Livestock-feed Balance - St. Louis trade territory. The analysis will use aggregate feed and livestock marketing data to program a livestock-feed balance for the St. Louis trade territory. Information will provide basic supply data for 1939, 1949, and 1959 for designated primary and secondary supply areas.

672-3N045 Chemistry and Chemical Engineering. First Order Least Square Fit to Kinetic Data. The research problem involves chemical kinetics. The best fit straight line is obtained by the method of least squares with the option of eliminating erroneous points. The IBM 7094 will be useful in obtaining this best fit.

673-3N046 Mechanical Engineering. Separated Flow Drag Coefficients. This program will give the drag coefficients for supersonic flow over two-dimensional notches. The methods used in the solution are standard gas dynamic solutions. These methods are Prandtl - Meyer Expansion, Oblique Shock, Isentropic expansion, and Momentum defect survey. The program also calculates ideal drag coefficients according to the linearized theory.

674-3N047 Electrical Engineering. Time Value of Money Factors. The 7094 will be used to solve problems dealing with the time value of money. A complete table of compound interest factors will be calculated.

675-3N049 Civil Engineering. Nematode Population. A correlation matrix taking into account 18 variables will be constructed. A one year survey was carried out in the local sewage treatment plant measuring nematode population at different sampling locations along with physical, chemical and bacteriological analysis of the waste. It is intended to evaluate the influence of these physical, chemical and bacteriological factors on the nematode population.

676-3N050 Geology. One Dimensional Fourier Analysis. The selective fixation of certain ions by silicate minerals, and in particular, the clay minerals, is presently under investigation. Structural analyses of the clay minerals can be accomplished utilizing one dimensional Fourier syntheses of X-ray diffraction data from oriented aggregate samples. Structural determinations before, and after, physical and chemical treatments of the clay materials can reveal structural change and ionic substitutions which may occur due to these particular treatments. Once the position of fixation in, or on, the clay mineral is determined, the method of fixation may be deduced.

The Fourier analyses utilized in the structural determinations are lengthy and time consuming. Use of the IBM 7094 will greatly expedite the determination of the fixation reactions through calculation of the Fourier syntheses, and allow greater flexibility in the stages of development of this research program.

677-3D001 Theoretical and Applied Mechanics. Postbuckling of Axially Stressed Circular Cylindrical Shells. The total potential energy, V, of an axially-stressed circular cylindrical shell can be formulated in terms of the generalized coordinates, X_i, of a Fourier cosine series expansion of the deflection normal to the shell surface. Stationary equilibrium configurations are determined by

$$f_j(X_i) = \frac{\partial V}{\partial X_i} = 0$$

The solutions, X_i, may then be obtained by using the Newton-Raphson iterative method such that

$$\left\{X_i\right\}^{k+1} = \left[\left\{X_i\right\} - \left\{f_{j,i}\right\}^{-1}\left\{f_j\right\}\right]^{k}$$

where k + 1 and k are iteration numbers. Convergence of similar equations has been achieved in, at most, four iterations. Double precision accuracy may be necessary in the calculation of $\left\{f_i\right\}$ since it approaches zero. $\left\{f_{j,i}\right\}$ is symmetric when axial stress is the independent variable and non-symmetric when axial deflection is the independent variable. Both formulations are essential in the description of shell buckling.

678-3D024 Institute of Communications Research. Studies of the 1962 Election. In an attempt to test a new theory of attitudes, 400 interviews, regarding preferences between Congressional candidates, were obtained from a quota sample of voters in this district in each of three time periods. These data are to be analyzed in order to compare members of different political parties, to isolate correlates of candidate preference, to specify the model by which these may be combined into a single predictor, and to determine the locus of change, if any, as a function of the campaign. Computer services are required in order to analyze both correlational and change data; programs used will include standard programs for correlation, factor analysis, rotation of factors, and analysis of variance.

679-3D003 Physics. Half Life Fitting. This program is intended to fit a complex radioactive decay curve. It will find the best values of the half life and of the initial activities of the components with their standard deviations and a parameter related with the goodness of the fit.

The mathematical method is the standard least squares method that in this case involve an iterative method due to the fact that the system of equations is not linear.

680-3D004 Electrical Engineering. Sound Analysis. The problem is to evaluate Fourier Transforms of sound pressure waves in order to learn more about their character.

681-3D006 Electrical Engineering. Random Antenna Arrays. The theory predicts that an antenna of extremely high resolution (which is of great interest today in space exploration) could be achieved with only one tenth or even one hundredth of the number of antenna elements required by a conventional design. Through a limited sample computation performed earlier, this has been proven to be true. This favorable result encourages further study. Since this is a study or random events, more samples are necessary in order to gain better confidence in the theory.

The computation to be performed, to a large extent, is similar to the previous one, using the Monte Carlo method. This will involve generation of random numbers, radiation pattern computation, and some statistics of the pattern function.

682-3D007 Chemistry and Chemical Engineering. Polymer Monte Carlo. This problem involves the generation of restricted random walks on various two and three dimensional lattices where a new method of checking for double occupancy is employed. The lattice, itself, will be stored in the high-speed core, rather than the sequence of vectors. This will enable faster computation of the end-to-end distances.

A subroutine for generating random sequences of two elements, where the entire sequence is tested statistically before being used in the physical problem, will be written.

683-3D008 Nuclear Engineering. Vapor Bubble Collapse. The computer will be used for the numerical solution of non-linear differential equations describing the collapse of vapor bubbles. The results will then be compared to experimental results. Reduction of experimental data to non-dimensional form and calculation of problem parameters will also be done on the computer.

684-3D009 Education. Meaning of Administrative Concepts. Beginning with the school year 1960-61, all advanced graduate students in school administration at the University of Illinois have been required to complete three common core courses (Ed. 461, Ed. 462, and Ed. 463) toward partial fulfillment of requirements for advanced degrees. Theoretically, these three courses should produce a kind, or kinds, of administrator identifiable through the cognitive meanings they choose to attach to the basic concepts stressed in the "mutual experience" model of the core.

But as yet it is empirically indeterminate whether such common experiences produce matriculates of the core who become more alike, or more different in respect to each other, and what influences may be associated with similarities or differences. Answers to these and associated questions might well furnish a factual undergirding for further development of the core model to increase the specific orientation of objectives, and the precision of methods to be employed.

In line with the central questions, several subquestions suggest themselves: in what ways do students of administration, who are aspiring to different specialties in their field, tend to "read" different meanings into "common" concepts; to what extent do "outside" administrative specialists (e.g. Business Administration students) attach similar meanings to core concepts, without having experienced the core courses; to what extent are noncore students of educational administration (Ed. 430, 440, 438, 460) similar to core students in the meanings they associate with basic core concepts; do the two most inclusive groups of public school administrators in the core program (high school and elementary school potential administrators) interpret the basic common core concepts as having different meanings; do students of education, at the graduate level, who have completed no courses in administration (classroom teachers), interpret the basic core concepts similarly to the students of administration.

685-3D011 Civil Engineering. Minimum Weight Design. The object of this study is to demonstrate the feasibility of using non-linear programming to find the minimum-weight elastic design of a steel structure, and to develop a procedure by which such a design might be accomplished. Using the matrix methods of structural analysis it is possible to write, in matrix form, a number of constraint inequalities specifying that computed stresses and deflections be not greater than allowable values. For standard economical structural steel sections it will be possible to obtain approximate relationships among the section properties. Thus a given constraint need contain only one property (the "member size") of a section as an unknown. Also, it will be possible to obtain a relationship giving the weight of a section in terms of its size, and hence an equation for the total weight of the structure in terms of the unknown member sizes. The problem then is to select the member sizes such that the constraints are satisfied and the total weight is minimized. This will be done by using the "steepest descent" method of nonlinear programming.

686-3D012 Agricultural Economics. Livestock Study. The linear programming routine will be used to obtain estimates of the transition probabilities in a Markov chain analysis of livestock production. The criterion of minimizing the absolute deviations about the regression line or plane will form the basis for estimating the transition probabilities.

687-3D013 Veterinary Physiology and Pharmacology. Irradiated Food Problems. This experiment is to determine the hemorrhagenicity genetic property of raw pork and the factors influencing it under irradiation used as a preservative. Most experimental designs to be tested are factorial. The least square method will be used.

688-3D014 Electrical Engineering. Adaptive System Simulation. A simple form of 'pattern classifier' which classifies a number of patterns (represented by n-bit binary words $\left[u_i\right]$) into m categories, can be represented by a matrix $\left[w_{ij}\right]$ of nxm elements. The category to which a given pattern belongs is found by calculating the value of m functions V_j $(j = 1 - m)$

where

$$V_j = \sum_{i=1}^{n} u_i - w_{ij}$$

and choosing the category corresponding to the largest V_j.

By appropriate choice of the values of w_{ij} the system can classify a number of patterns according to a predetermined scheme. The values of w_{ij} may be found by an iterative procedure in which the classification obtained is evaluated after each trial, and if correct, all the w_{ij} which contributed towards the correct response are increased by Δw_1 and if incorrect decreased by Δw_2.

The object of the program is to obtain an estimate of the mean number of trials, T, which are required before a correct set of responses is obtained, and of the dependence of T on the magnitude of Δw_1, Δw_2, and n and m.

689-3D015 Electrical Engineering. Analysis of Circular Antenna Arrays. Pattern calculations will be performed on a circular monopole antenna array above ground. The first part of the analysis will consist of pattern calculation due to two active elements of the circular array. The second part of the analysis will consist of introducing parasitic elements in conjunction with the active elements and studying the effect on the pattern calculations.

690-3D016 Mining, Metallurgy and Petroleum Engineering. Evaluate Single Relaxation Times. Magnetic relaxation of nickel due to lattice defects is being studied. The simplest approach to explain the relaxation is to assume a single relaxation time which would lead to a time dependance of the induction B of the form $B(t) = B_o \exp(-t/\tau)$. Due to experimental difficulties B (t) and B_o can only be determined to within an additive constant a, giving

$$B(t) + a = (B_o + a) \exp(-t/\tau) \quad .$$

It is intended to use the IBM 7090 in order to find out whether the experimental curves can be understood in terms of a single relaxation time and if not, what the change of the apparent single relaxation time, determined within a short measuring period, over the whole B (t) -curve will be. This latter information will give hints on how to improve the analysis.

If one takes two equations of the above form for different times t and the related B's, one gets one equation for τ which will be solved by Newton's method. The initial guess will be calculated in such a way that the program finds the solution wanted. The evaluation process will be stopped if the difference of two consecutive τ's is less than 10^{-4}. This calculation will be repeated for several data sets t , B listed in two one dimensional arrays.

691-3D017 Electrical Engineering. Log-Periodic Helical Dipole Arrays. Log-periodic dipole arrays have achieved wide usage in recent years as practical broadband antennas. At low frequencies, however, the log-periodic dipole becomes quite large, because of the half-wavelength dimensions of its radiating elements. By replacing these elements (linear half-wave dipoles) with helical dipoles, one can achieve a considerable size-reduction.

Laboratory tests have been and are being performed on size-reduced arrays, and have proven the feasibility of such arrays. It is now desired to construct a mathematical model of these and related antennas, and to use this model to help in predicting their performance as design parameters and frequency are varied.

The mathematical model is expressed by the equation

$$I = (U + Y_F Z_A)\, I_A$$

where I_A and I are column matrices representing unknown dipole currents and known currents applied to the antenna, respectively; Y_F and Z_A are n-by-n matrices characteristic of the antenna with n dipoles, and U is the unit matrix. Each element in the matrix Z_A is, in general, given by a sum of five integrals; these may be written as a long string of cosine integrals and sine integrals. The elements in both Z_A and Y_F are complex-valued.

In order to investigate the effect of changing the frequency and the antenna parameters upon its performance, these factors are inserted into the elements of Z_A and Y_F. It is hoped that the 7094 computer will be of great value in carrying out the large amount of routine calculations involved in solving the above equation for the matrix I_A, and in carrying out the solution repeatedly for many different sets of antenna design parameters. This solution for I_A opens the door to several further sets of calculations, each describing some aspect of the antenna performance.

692-3D018 Physics. M.U.R.A. Bubble Chamber Program. A subroutine to calculate fiducial points on M.U.R.A. Bubble Chamber pictures will be written. This will eventually be a part of the program complex which will carry out the analysis of such photographs after they have been processed on the scanning-measuring projector (SMP.) The 7094 is to be used with simulated data points to optimize the routine to be written.

693-3D019 Digital Computer Laboratory. Plotting Analogue Simulator. This problem will develope a program to simulate an X-Y plotter for a presently available analogue computer simulator program, MIDAS. Output from the Modified Integration Digital Analogue Simulator program will be stored on up to 3 tapes (simulating up to 3 plotters) which will then be processed when the simulation is done.

Plotting will be done on two mediums - on-line scope and off-line printer.

694-3D020 Civil Engineering. Extension of Critical Path Method. The problem in question is the extension of the critical path method to include the concept of limited resources (i.e. manpower and equipment). Laboratory Routine HØ-UØI-CPP1-50-SR, as modified for the University of Illinois 1401-7094 system by W. L. Meyer of the Civil Engineering Department, will be utilized in an attempt to solve the problem via integer linear programming.

695-3D021 Mathematics. Circuit Analysis. An attempt will be made to determine the applicability of the 7094 to the analysis and particularly to the design of electronic circuits, especially as applied to communications equipment.

696-3D022 Physics. Analysis of SMP Data. Data obtained by measurement of bubble chamber photographs with an SMP connected on-line to the direct-data connection of the 7094 will be analyzed. A library of 9AP and Fortran programs developed at Berkeley will be used for stereo reconstruction, kinematical analysis and relativistic computations of the data.

697-3D023 Chemistry and Chemical Engineering. Nuclear Quadrupole Studies. The problem will consist of calculating the rigid rotor spectrum of various molecules and taking into account the various perturbations such as quadrupole splitting, Stark effect, etc. which may occur in particular cases. For the most part the programs necessary to accomplish this end have already been written, checked, and are currently in use at this computing center, however, for future problems these programs may have to be revised because of increasing molecular complexity.

During the month of December there were 3 Instructional Problem Specifications submitted to the IBM 7094.

I101-3N043 Industrial Engineering 237. Problem No. 1. Space Requirements for Factory Training. Large manufacturing organizations are frequently faced with skilled manpower demands which cannot be met by the Personnel Department and must set up factory training programs to obtain these specialized workers. The required space must be determined based on the type and extent of training to be given and space needed for this use.

This problem is concerned with the determination of the number of classrooms needed and the areas required for the classrooms and associated workshops per month over an extended period into the future by the Space Allocations Department. A schedule of the number and kind of workers to be trained each month is the only information supplied to the Space Allocations Department.

Standard data have been developed from studies of the situation to include such information as the number of trainees per classroom, the departmental area per trainee for classroom and for workshop and other special allowances. Special formulas have been constructed based on the various relationships to obtain the number of classrooms and the areas required.

Other data is provided for print out so that the results of the new computations can be readily compared with projections of space already allocated and available space.

I102-3D005 Theoretical and Applied Mechanics 293. Problem No. 1. Dynamic Pressure Around a Cylinder. A Fortran program will be run which will calculate data for constant pressure lines around a cylinder. Then the General Alphanumeric Cathode Ray Display and Fortran Axis and Point Plotter will be used to plot the numeric information.

I103-3D002 Civil Engineering 391. Problem No. 4. Pipe Diameter Calculation. For a circular pipe flowing full, the required diameter, in feet, is given by the formula:

$$\frac{D^5}{f} = \frac{8 L Q^2}{\pi^2 g h_f}$$

where Q = flow, cubic feet per second
L = length, feet
g = acceleration of gravity
h_f = head loss, feet

The friction factor f can be approximated as

$$f = 0.0055 \left[1 + \left(20{,}000 \frac{\epsilon}{D} + \frac{10^6}{N_R}\right)^{1/3} \right]$$

where ϵ = absolute roughness, feet

N_R = Reynolds number $= \frac{4Q}{\pi D v}$

v = viscosity, ft^2/sec.

The simultaneous solution of these equations can be accomplished by successive approximations. Note that while the criterion for convergence is obviously related to successive values of D, it is more convenient to use in the first iteration an approximate value of f.

Write a program to compute D, given ϵ, v, Q, L, and h_f.

Information on the utilization and reliability of the IBM 1401s and IBM 7094 for the month of December, 1963 is given in the tables below.

TABLE I - IBM 1401-I
SUMMARY OF USE
DECEMBER, 1963

Scheduled Engineering	6:08
Unscheduled Engineering	16:05
Maintenance	10:27
7094 Preparation	336:45
Listing	8:42
Monthly Report Listing	1:55
Tape Dump	6:35
Code Check	3:15
Scanning Measuring Projector	21:08
Reproduction	8:02
Tape Test	11:30
Tape Copy	:30
Idle	101:45
Total Running Time	532:47

TABLE II - IBM 1401-I
SUMMARY OF MACHINE ERRORS
DECEMBER, 1963

1401 Main Frame and Storage	3
1402 Read-Punch	7
1403 Printer	2
729 V Tape Units	1
Total	13

DATE	RUNNING OK TIME	IDLE	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	TOTAL TIME	FAIL-URES	DAILY TIME DISTRIBUTION
12/01/63	1:45					1:45	0	
12/02/63	13:53		1:05		1:02	16:00	0	
12/03/63	14:03	7:17		1:25	1:15	24:00	1	(1) Character failing to print due to loose screw on printing chain. Engineer replaced chain and returned broken chain for repairs.
12/04/63	21:56	1:19			:45	24:00		
12/05/63	21:24	1:46			:50	24:00		
12/06/63	21:30	1:45			:45	24:00		
12/07/63	16:09	4:46				20:55		
12/08/63	4:00					4:00	1	(1) ID cards only partially punched. Trouble not found.
12/09/63	12:57	1:20	1:28		:15	16:00	2	(1) Carriage ran away; power cut. Did not reoccur when power was restored. (2) Unexplained process errors; trouble did not reoccur.
12/10/63	19:09	3:01		1:00	:50	24:00	2	(1) and (2) Cards punched and fed into wrong stackers. Engineer called. Punch stacker armature cleaned. Failure corrected.
12/11/63	17:22	5:58			:40	24:00		
12/12/63	21:25	:30		2:05		24:00	2	(1) Index Register 2 suspected to be in error. Tests were run but no error was found. (2) Door on unit B not working properly. Repaired by engineer. Engineering to check Index Register 2. Errors in carrying found.
12/13/63	18:14	4:15		:30	1:01	24:00	0	
12/14/63	13:17	7:53				21:10	0	
12/15/63	6:11	1:23				7:34	0	
12/16/63	13:33	1:10	3:35		:40	18:58	0	
12/17/63	20:05	3:30			:25	24:00	1	(1) Cards from punch falling into wrong stacker. Cards were run out and start pressed to correct.
12/18/63	12:35	5:05		6:20		24:00	1	(1) Stacker select failure due to faulty I/O Check Stop Switch. Switch was replaced by engineer.
12/19/63	13:45	5:30		4:45		24:00	2	(1) Unexplained punch stops on 1402. (2) Punch errors resulting from cams not keeping in time. Engineer timed cams and trouble disappeared.
12/20/63	16:25	7:05			:30	24:00	0	
12/21/63	13:27	7:23				20:50	0	
12/22/63	:10					:10	0	
12/23/63	10:03	5:27			:30	16:00	0	
12/24/63	11:21	1:24				12:45	0	
12/26/63	7:56	7:39			:25	16:00		
12/27/63	17:57	6:03				24:00	0	

TABLE III - IBM 1401 - I Continued — December 1963

DATE	RUNNING OK TIME	IDLE	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	TOTAL TIME	FAIL-URES	DAILY TIME DISTRIBUTION
12/28/63	10:37	5:10			:24	16:11	1	(1) Card jam in punch side of 1401. Cards removed.
12/29/63	2:13	1:46				3:59	0	
12/30/63	14:10	1:40			:10	16:00	0	
12/31/63	10:50	1:40				12:30	0	
	398:22	101:45	6:08	16:05	10:27	532:47		

TABLE I - IBM 1401-II
SUMMARY OF USE
DECEMBER, 1963

Unscheduled Engineering	3:09
Maintenance	10:00
7094 Preparation	335:14
Listing	12:17
Monthly Report Listing	3:25
Tape Dump	2:55
Code Check	5:09
Scanning Measuring Projector	7:30
Reproduction	6:51
Tape Test	:50
Idle	138:25
Total Running Time	525:45

TABLE II - IBM 1401-II
SUMMARY OF MACHINE ERRORS
DECEMBER, 1963

1401 Main Frame and Storage	1
1402 Read-Punch	2
1403 Printer	4
729 V Tape Units	1
Total	8

TABLE III - IBM 1401-II

December 1963

DATE	RUNNING OK TIME	IDLE	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	MAIN-TENANCE	TOTAL TIME	FAIL-URES	DAILY TIME DISTRIBUTION
12/02/63	15:02				:58	16:00	0	
12/03/63	17:00	5:45			1:15	24:00	0	
12/04/63	15:03	8:12			:45	24:00	1	(1) Consistent Reader check; no apparent reason. Trouble disappeared.
12/05/63	14:16	7:25		1:15	1:04	24:00	1	(1) 1403 gives print check after writing one line. Three blown fuses found in 1403. Replaced by engineers.
12/06/63	15:35	7:55			:30	24:00	2	(1) Consistent Sync. checks on 1403. Trouble disappeared. (2) 1403 not printing 12th position. Blown fuse found and replaced.
12/07/63	2:37	17:23				20:00	0	
12/08/63	3:45					3:45	0	
12/09/63	15:35	:05			:20	16:00	0	
12/10/63	22:35	:35		:10	:40	24:00	1	(1) Unidentified Process errors. I/O test read in and trouble disappeared.
12/11/63	20:55	2:10			:55	24:00	0	
12/12/63	19:36	3:59		:05	:20	24:00	0	
12/13/63	21:48	1:50			:22	24:00		
12/14/63	10:22	9:38				20:00		
12/15/63		8:00				8:00		
12/16/63	13:44	1:30			:46	16:00	0	
12/17/63	18:15	5:25			:20	24:00	0	
12/18/63	22:16			1:39	:05	24:00	1	(1) Hammer failure on 1403. Repaired by engineer.
12/19/63	23:40	:15			:05	24:00	0	
12/20/63	20:35	3:00			:25	24:00	1	(1) ID cards only partially punched. Cause of trouble not determined.
12/21/63	6:25	13:35				20:00	0	
12/23/63	10:50	4:40			:30	16:00	0	
12/24/63	6:25	5:45				12:10	0	
12/25/63	:42					:42	0	
12/26/63	11:37	4:02			:25	16:04	0	
12/27/63	18:00	6:00				24:00	0	
12/28/63	4:23	12:12				16:35	1	(1) Tape unit C fails to load properly. Trouble not determined.
12/29/63	2:40	1:49				3:29	0	
12/30/63	12:50	3:05			:05	16:00	0	
12/31/63	7:40	4:10			:10	12:00	0	
	374:11	138:25		3:09	10:00	525:45	8	

TABLE I - IBM 7094

SUMMARY OF USE

DECEMBER, 1963

Scheduled Engineering	25:31
Unscheduled Engineering	32:27
Air Conditioning	:28
Operator Training	1:13
System Updating	3:28
Production	332:43
On-Line Time-Shared Use Via the Direct Data Connection	209:39
Instruction	3:25
Miscellaneous (Tape rewind, tape mounting, both system and user, rerun of failing problems, tape skipping, destruction of clock readings)	135:06
	744:00

TABLE II - IBM 7094

SUMMARY OF MACHINE ERRORS

DECEMBER, 1963

7094	3
7110 Instruction Processing Unit	1
7607 I Data Channel	1
7631 II File Control	1
716 Printer	2
711 Card Reader	2
CRT	4
729 VI Tape Units	16
Tape	9
	39

TABLE III - IBM 7094 December, 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANI-PULATION	TOTAL RUNNING TIME	FAIL-URES	DAILY DISTRIBUTION TIME
12/01/63	15:30		8:30			24:00	1	(1) Divide errors in 7110. Bad card found and replaced by engineer.
12/02/63	16:31	2:00	1:17		4:12	24:00	2	(1) Successive redundancy checks on Unit R. Unit adjusted and trouble disappeared. (2) Tape Unit R will not read or write properly. Unit removed from service. CRT removed from service at 0800. Returned at 1700. Tape Unit V being adjusted on-line.
12/03/63	15:05	1:50	2:53		4:12	24:00	4	(1) Tape Unit R giving continuous errors. Adjusted by engineer. (2) Tape Unit R giving continuous errors. Engineer increased gain on amplifiers and returned to service. (3) Tape Unit R still giving errors. Engineer replaced card in read gate circuit. (4) CRT not functioning properly.
12/04/63	16:19	:53			6:48	24:00	1	(1) Successive errors in Fortran. Trouble disappeared.
12/05/63	17:39				6:21	24:00	1	(1) Repeated machine errors in Fortran. MTII replaced and trouble disappeared.
12/06/63	17:48		:10		6:02	24:00	2	(1) Excessive tape errors. MT1 replaced and trouble disappeared. (2) Repeated machine errors in Fortran. Tapes replaced and trouble disappeared.
12/07/63	16:18		2:21		5:21	24:00	2	(1) Tapes on Units S and Y ran off the end on successive occasions. Units cleaned and other tapes tried with same result. Engineer found no cause for trouble. (2) Relay jammed on Unit Y. Repaired by engineer.
12/08/63	24:00					24:00	0	
12/9/63	18:09	:30	:05		5:16	24:00	3	(1) Tape fell in vacuum columns and unit would not reset. Head raised by engineer and tape removed. (2) Repeated errors in Fortran. MTI and scratch tape on Unit Q replaced and trouble disappeared. (3) Left drive wheel on tape Unit V frozen. Bad card found and replaced.
12/10/63	15:57	:30			7:33	24:00	0	

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANI-PULATION	TOTAL RUNNING TIME	FAIL-URES	DAILY DISTRIBUTION TIME
12/11/63	16:29	:20	1:02		6:09	24:00	4	(1) Unit Q making noise. Oiled by engineer. (2) Unit W taken off-line to repair file protect switch. (3) 7631 taken off-line because of parity errors. (4) Card jam in 711. Jam removed and unit cleaned by engineer.
12/12/63	18:22	:40	:20		4:38	24:00	2	(1) Printer making noise. Clutch was greased by engineer. (2) Repeated errors in Fortran. Units cleaned and MTI replaced. Trouble disappeared.
12/13/63	14:01	1:43	2:32	:28	5:16	24:00		
12/14/63	19:01		1:05		3:54	24:00	1	(1) Tape Unit S could not be loaded. Loose wire found by engineer.
12/15/63	22:29				1:31	24:00	1	(1) Scope down and taken off-line.
12/16/63	17:50	2:00	:35		3:35	24:00	1	(1) Disk file not working properly. Card replaced in 7607. Disk file continues to register errors. File turned off. Testing and adjusting 1301 on-line.
12/17/63	13:47	:10	5:07		4:56	24:00		
12/18/63	16:07				7:53	24:00	1	(1) Overload system on CRT failed. CRT taken off-line.
12/19/63	17:08				6:52	24:00	0	
12/20/63	21:27				2:33	24:00	2	(1) Unable to update. MTI was replaced and update was successful. (2) Machine errors in Fortran. Bad tape found on B4 and replaced.
12/21/63	15:28				8:32	24:00	0	
12/22/63	24:00					24:00	0	
12/23/63	16:13	1:50			5:57	24:00	3	(1) 716 failed to operate. Engineer called and replaced generator belt. (2) Tape Unit Q malfunctioning. Engineer lubricated Unit Q and trouble disappeared. (3)711 failing to feed properly. Suspected bad cards. CRT still not working. Scheduled engineering on CRT.
12/24/63	20:35	1:00			2:25	24:00	0	
12/25/63	24:00					24:00	0	
12/26/63	16:51	1:50			5:19	24:00	3	(1) Tape Unit R fails to select. Loose connection repaired by engineer. (2) Excessive errors in Fortran. Trouble disappeared. (3) Repeated errors in Fortran. MTI switched from Unit R to V and trouble disappeared.

TABLE III - IBM 7094 (Continued)

December 1963

DATE	RUNNING OK TIME	SCHEDULED ENGINEERING	UNSCHEDULED ENGINEERING	AIR CONDI-TIONING	OPERATOR MANI-PULATION	TOTAL RUNNING TIME	FAIL-URES	DAILY DISTRIBUTION TIME
12/27/63	13:22	3:20	:50		6:28	24:00	3	(1) CRT failed to come on ready status temporarily. (2) Repeated errors in Fortran. Tape Units cleaned and trouble disappeared. (3) Repeated errors in Fortran. MTI replaced and trouble disappeared.
12/28/63	14:17		5:25		4:18	24:00	1	(1) Tape Unit Q failed and taken off-line.
12/29/63	23:12				:48	24:00	0	
12/30/63	16:50	1:55	:15		5:00	24:00	1	(1) Unexplained errors in Fortran.
12/31/63	15:43	5:00			3:17	24:00	0	
	550:28	25:31	32:27	:28	135:06	744:00	39	

DEPARTMENT	Number of Runs			Total Number of Runs	Number of Prob. Specs.			Total Number of Problem Specs.	Time Used			On-Line Time Shared Use Via the Direct Data Connection	Total Time Used
	Class	Research	Non System		Class	Research	Non System		Class	Research	Non System		
Aeronautical and Astronautical Engineering	64	177		241	2	7		9	:52	3:03			3:55
Agricultural Engineering		67		67		4		4		:47			:47
Agricultural Economics		154	7	161		7	3	10		2:18	2:19		4:37
Agricultural Education		6		6		1		1		:12			:12
Agronomy	207	164		371	1	13		14	3:21	4:12			7:33
Animal Science		15		15		3		3		:26			:26
Astronomy		15		15		2		2		:14			:14
Bureau of Economic And Business Research		54		54		3		3		:30			:30
Biophysics		10		10		1		1		:18			:18
Civil Engineering	1061	728		1789	10	32		42	12:43	22:53			35:36
Ceramic Engineering		40		40		1		1		:27			:27
Chemistry and Chemical Engineering	449	1117		1566	1	34		35	9:05	45:21			54:26
Children's Research Center		4		4		1		1		:04			:04
Center for Zoonoses Research		57		57		2		2		1:24			1:24
Digital Computer Laboratory	413	819	34	1266	2	23	8	33	4:06	21:49	8:33		34:28
Dairy Science		24		24		3		3		:18			:18
Economics	18	69		87	1	5		6	:24	1:10			1:34
Education		70		70		5		5		1:24			1:24
Educational Testing		10		10		1		1		:11			:11
Electrical Engineering	502	156		658	11	15		26	5:11	3:29			8:40
Forestry		16		16		2		2		:25			:25
General Engineering		9		9		2		2		:11			:11
Geology		22		22		1		1		:12			:12
Business Administration, Graduate School	226	29		255	2	1		3	2:55	:41			3:36
Institute of Communications Research		42		42		3		3		:56			:56
Industrial Engineering	167	5		172	2	1		3	1:55	:04			1:59
Institute of Government and Public Affairs		7		7		1		1		:09			:09
Instructional TV		29		29		1		1		1:19			1:19
Mathematics	3164	27		3191	2	2		4	30:36	:24			31:00
Mechanical Engineering	385	559		944	5	20		25	4:16	17:09			21:25
Mining, Metallurgy, and Petroleum Engineering		24		24		4		4		:13			:13

IBM 7094 - TABLE IV (Continued) December, 1963

DEPARTMENT	Number of Runs			Total Number of Runs	Number of Prob. Specs.			Total Number of Problem Specs.	Time Used			On-Line Time Shared Use Via the Direct Data Connection	Total Time Used
	Class	Research	Non System		Class	Research	Non System		Class	Research	Non System		
Men's Residence Hall Association Rocket Club		10		10		1		1		:16			:16
Natural History Survey		2		2		1		1		:03			:03
Nuclear Engineering	5	145		150	1	3		4	:12	10:51			11:03
Office of Instructional Research		48		48		1		1		:24			:24
Physical Education for Men and Graduate PE		1		1		1		1		:01			:01
Physics	1	1222	43	1266	1	31	2	34	:01	43:44	9:38	209:39	263:02
Political Science		24		24		1		1		:18			:18
Psychology		622		622		30		30		23:25			23:25
Sociology		2		2		1		1		:12			:12
Statistical Service Unit		453	3	456		2	1	3		11:54	:30		12:24
State Water Survey		103		103		9		9		:56			:56
Theoretical and Applied Mechanics	32	152		185	3	10		13	:25	11:11			11:36
Zoology		3		3		1		1		:02			:02
Sub Total	6694	7312	87	14039	44	293	14	351	76:02	235:29	21:00	209:39	542:08
Instruction		376		376		1		1		3:39			3:39
Grand Total	6694	7688	87	14469	44	294	14	352	76:02	239:08	21:00	209:39	545:47

PART V

GENERAL LABORATORY INFORMATION

Colloquia

"Executive Program Control System," by Mr. Stanley Cohen, Argonne National Laboratory, Argonne, Illinois, December 9, 1963.

"The Transfer Memory of the ILLIAC III Computer," by Professor S. R. Ray, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, December 16, 1963.

Personnel

The number of people associated with the Laboratory in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	15	1	15.5
Visiting Faculty	5	1	5.5
Research Associates	3	0	3.0
Graduate Research Assistants	3	49	27.2
Graduate Teaching Assistants	0	5	2.2
Professional Personnel	5	1	5.5
Administrative and Clerical	10	0	10.0
Other Nonacademic Personnel	46	78	78.0
TOTAL	87	135	146.9

The Computer Advisory Committee consists of Professors H. C. Brearley, J. R. Ehrman, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, G. A. Metze, D. E. Muller, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith, J. N. Snyder, and A. H. Taub.

Drafting

During December a total of 115 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	7	1
Medium Drawings	1	0
Small Drawings	5	14
Reports (General)	25	Several
Reports (1834)15	43	0
Change Orders	18	0
Miscellaneous	1	0
TOTAL	100	15

(K. C. Law, P. Richardson)

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UNIVERSITY OF ILLINOIS
GRADUATE COLLEGE
DIGITAL COMPUTER LABORATORY

IBM 7090 LIBRARY INDEX

JUNE 27, 1963

LABEL	DATE	TITLE
B1-UOI-ATN2-14-S	11/2/62	FIXED POINT ARCTANGENT
B1-UOI-SIN1-9-S	10/11/62	FLOATING POINT SINE-COSINE
B1-UOI-SIN2-10-S	8/6/62	FIXED POINT SINE AND COSINE
B3-UOI-EXP4-5-S	10/1/62	FIXED POINT EXPONENTIAL, BASE E
B3-UOI-EXP5-4-S	11/2/62	FLOATING POINT EXPONENTIAL
B3-UOI-EXP6-6-S	11/2/62	FIXED POINT EXPONENTIAL, BASE 2
B3-UOI-EXP7-7-S	11/2/62	FIXED POINT EXPONENTIAL, BASE E
B3-UOI-LOG1-8-S	10/11/62	FLOATING POINT NATURAL LOGARITHM
B3-UOI-LOG3-12-S	10/22/62	FIXED POINT LOGARITHM, BASE E
B3-UOI-LOG4-13-S	10/22/62	FIXED POINT LOGARITHM, BASE 2
B4-UOI-CUR2-11-S	10/15/62	FLOATING POINT CUBE ROOT
B4-UOI-CUR3-38-SR	6/17/63	FLOATING POINT CUBE ROOT*
B4-UOI-SQR1-22-S	11/15/62	FIXED POINT SQUARE ROOT
B4-UOI-SQR2-3-S	4/5/63	FLOATING POINT SQUARE ROOT
B4-UOI-SQR3-24-S	11/28/62	FIXED POINT SQUARE ROOT
C3-UOI-CEI1-21-S	11/14/62	COMPLETE ELLIPTIC INTEGRALS, FIXED POINT
C3-UOI-FAC1-16-S	10/31/62	FLOATING POINT FACTORIAL
C3-UOI-FAC2-27-SR	2/25/63	FLOATING POINT FACTORIAL (FORTRAN, MAD, SCAT)
D1-UOI-SIM1-30-FR	4/3/63	INTEGRATION BY SIMPSON'S 3 POINT RULE
D2-UOI-ADM3-36-SR	5/30/63	FOURTH ORDER ADAMS-MOULTON INTEGRATOR*
D2-UOI-RKY1-17-S	10/30/62	FIXED POINT RUNGE-KUTTA
D2-UOI-RKY3-20-S	11/14/62	FLOATING POINT RUNGE-KUTTA
F1-UOI-MAM1-26-S	2/19/63	FLOATING POINT MATRIX MULTIPLICATION
F1-UOI-MAM2-37-SR	6/11/63	DOUBLE PRECISION FLOATING POINT MATRIX MULTIPLICATION*
F2-UOI-EIG1-29-FR	3/20/63	FLOATING POINT EIGENVALUES AND EIGENVECTORS OF A SYMMETRIC MATRIX
F4-UOI-INV1-34-FR	5/8/63	MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF LINEAR EQUATIONS (FORTRAN II)*
F4-UOI-LSQ1-31-FR	5/3/63	LEAST SQUARE POLYNOMIAL FIT (FORTRAN II)*
F4-UOI-LSQ2-32-FR	5/3/63	A GENERAL PROGRAM FOR LEAST SQUARE POLYNOMIAL FIT (FORTRAN II)*
G5-UOI-RAN1-35-SR	5/15/63	GENERATE FLOATING OR FIXED POINT NUMBERS PSEUDO-UNIFORMLY DISTRIBUTED ON (0,1)*
J5-UOI-PLOT-33-RX	5/2/63	PLOT GRAPHS ON THE OFF-LINE PRINTER*
J5-UOI-SCP1-23-SR	3/6/63	GENERAL AXES AND POINT PLOTTER
J5-UOI-SCP2-28-SR	3/6/63	FORTRAN AXES AND POINT PLOTTER

J5-UOI-SCP3-15-SR	3/6/63	GENERAL ALPHANUMERIC CATHODE RAY DISPLAY
L1-UOI-SCRE-19-BX	1/28/63	SCATRE
L1-UOI-SSA1-1-BX	4/26/62	SCAT
L2-UOI-MAD1-2-BX	6/20/62	MAD
M2-UOI-CNV1-18-S	11/5/62	FIXED POINT BINARY FRACTION TO BCD CONVERSION
00-UOI-S650-25-BX	4/11/63	IBM 650 SIMULATOR ON 7090-1401 SYSTEM (SIM650)

* NEW ROUTINES ADDED TO LIBRARY SINCE INDEX DATED 5/2/63